APPENDIX III

TAB K

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IN THE UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF PENNSYLVANIA

TAMMY KITZMILLER, et al.,

Plaintiffs,

vs. No. CV 04-2688

DOVER AREA SCHOOL DISTRICT;
DOVER AREA SCHOOL DISTRICT
BOARD OF DIRECTORS,

Defendants.

DEPOSITION OF KEVIN PADIAN
Oakland, California
Tuesday, May 10, 2005

Reported by:
ANA VIDA REID
CSR No. 11926
JOB No. 62669

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DOVER AREA SCHOOL DISTRICT;
DOVER AREA SCHOOL DISTRICT
BOARD OF DIRECTORS,

Defendants.

Deposition of KEVIN PADIAN taken on behalf of Defendants at 1999 Harrison Street, Oakland, California, beginning at 9:28 a.m. and ending at 5:52 p.m. on Tuesday, May 10, 2005, before ANA VIDA REID, Certified Shorthand Reporter No. 11926

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EXHIBITS

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Oakland, California, Tuesday, May 10, 2005
9:28 a.m. - 3:52 p.m.

KEVIN PADIAN,
having been first duly sworn, was examined and testified as follows:

EXAMINATION

BY MR. GILLEN:

Q Good morning, Dr. Padian. My name is Patrick Gillen. We met off the record, but let me introduce myself again for the purposes of the record. I'm an attorney for the defendants in this case, Dover Area School District and the school board, and I'm here today, as you know, to take your deposition in this manner. As I see it, to learn the basis for the expert opinion, which you provided in this case.

There are few features of this process that are somewhat unusual. The first is that the questions and answers, they're verbal, but we have to make sure that we wait until -- that all responses are verbal, first of all. And second, that we wait until each other is done speaking before we talk so that Ana can get a good transcription.

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Another part of the process that tends to be highlighted here is that in precision of human communication, and I can assure you that after looking at the report, that there may be -- or there will be certain areas where I'm struggling just to understand that basis for your answer. Please bear with me if my questions are imprecise and tell me that you find them so, and I'll try to clarify them to the extent I can. By the same token, you know, if you -- if I struggle with your answer, please bear with me as I try and understand them.

We are somewhat late, and I regret that. It's not an endurance contest. If you need a break, please let me know. If there's any question I ask you that makes you uncomfortable or something that you don't feel that you'd like to talk about, please let me know, and I'll try to avoid that to the extent I can. I think that's about it for the general protocols.

Would you state your full name for the record.

MR. ROTHSCHILD: I'm sorry, before we go on. I assume we're going to operate under normal stipulations, all objections, except as to form, are preserved to trial?

MR. GILLEN: I agree.

MR. ROTHSCHILD: And I've requested, and you've

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agreed off the record, that we can have 60 days to read and sign rather than the usually 30?

MR. GILLEN: Yes.

MR. ROTHSCHILD: Thank you.

MR. GILLEN: No problem.

BY MR. GILLEN:

Q Would you please state your full name for the record.

A My full name is Kevin Padian.

Q Okay. Current address?

A Home address?

Q Yeah.

A 425 Yale in Kensington, California 94708.

Q How would you prefer that I address you for the purpose of the deposition?

A First names are fine. It really doesn't matter.

Q The same with me, please.

A Okay.

Q Have you been deposed before?

A Yes. About maybe ten years ago in a different case.

Q What case was that?

A It had something to do with the Institute for Creation Research losing its accreditation in the State

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of California.

Q Was it a state court proceeding, do you know?

A I believe it was state court, yeah. Although it was so long ago, I don't remember the details.

Q Okay. And you say about ten years ago?

A Yeah. At least, yeah.

Q And it was the Institute for Creation Research?

A Creation Research, yeah, down in San Diego. And they were -- they were contesting it against Bill Honig, who was then State Superintendent of Education, Public Instruction.

Q And for what purpose did you testify in that proceeding?

A Whether the creation of science that they were teaching was, in fact, good science that should be taught in schools.

Q Do you know the result of that proceeding?

A I believe, I think they got their accreditation back, but I'm not sure. I don't remember the result anymore.

Q And if you could describe for me, please, generally, the thrust of your testimony in that proceeding. Did you address, as you have here, the role of Paleontology?

A It was so long ago, I can't remember all of the

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things that were asked. I don't remember that it took very long, and I think it had to do with why creation science wasn't science.

Q Were there other experts who testified in that proceeding?

A I don't know. I don't remember.

Q Who retained you?

A I don't remember that either.

Q Okay. Do you know if perhaps the State retained you?

A That might have been. And I'm trying to think whether now it was an expert witness or whether they just called me as a witness. I think maybe it was not an expert witness.

Q Okay.

A I think in that case. So this would be then the first.

Q But you answered my question honestly, which is, had you testified in any other proceedings. Is that the only one?

A Yes, I believe so. And that was just a deposition, that didn't go to trial with me.

Q How about, have you offered any expert opinions via affidavit or declarations in other proceedings?

A Personally no, I don't think so.

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Q You say "personally," is there a particular reason?

A Because I don't know if you would consider if my -- if the nonprofit organization, of which I am president, offers an amicus brief, which is not me, and that's what I -- do you mean those things?

Q I appreciate your -- the forthcomingness of your answer. I was going to ask you about the next -- I just want to get a sense for the declaration, sort of something where either at the end of the -- at the beginning of you're sworn or at the end, you say true and correct to the best of my knowledge under penalty of perjury.

A Yeah, I don't remember anything.

Q But I do know from your report and CV that you are also the head of the NCSC, right?

A Yes.

Q And you mentioned an amicus brief that was filed by the NCSC?

A They may have done so. I don't remember specific cases on this, but -- I mean, if there are such. And I should say that, yeah, I am the -- I'm the president of NCSC. I'm the president of the board, but the day-to-day work is done by the people in the office. And so, I don't really decide about amicus briefs. I'm

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not involved with writing them. That's what the people in the office do.

Q When you say the "day-to-day work is done by the people in the office," who are you referring to?

A The executive director, Dr. Eugenie Scott, and her staff.

Q Now, it's my understanding that you have consulted with the plaintiffs in this case prior to being retained as an expert?

MR. ROTHSCHILD: When you say "you," what are you referring to?

THE WITNESS: The plaintiffs, I'm not sure. Who -- if you're talking about the Dover parents, no, I haven't.

BY MR. GILLEN:

Q No. And that's -- these are all fair questions. Let me try and make my question more precise.

Have you personally served as a consulting expert with the plaintiffs in this action prior to the filing of the lawsuit?

A No.

Q Do you know if anyone at the NCSC has served as a consulting expert prior to the filing of the lawsuit?

A I don't know. You would have to ask when any

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of those people were contacted.

Q And when you say "any of those people," who are you referring to?

A At the staff, whether its Genie Scott and her staff people.

Q Okay.

A You'd have to ask them when they may have heard of this or what contact they may have had.

Q If the NCSC staff had agreed to serve as a consulting expert for the plaintiffs or their attorneys in this case, who would make that decision?

A That would be Dr. Scott's decision.

Q Who else -- you mentioned her staff. Who else works with Dr. Scott on a day-to-day basis at the NCSC?

A Gee, Glenn Branch is our deputy secretary. Nick Matzke, which is spelled M-a-t-z-k-e, I think, is on the staff there. We have a couple of people who are accountants and financial people. There is an archivist, Susan Spath is another person who coordinates research. I think Wes Elsberry, which would be E-l-s-b-e-r-r-y, is a researcher there. And Eric Meikle, which is Eric M-e-i-k-l-e. And either people -- there may be other people who come and go, but they're not they're with us for a while.

Q Of the names you mentioned, do you know if

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anyone has served as a consultant to the plaintiffs or their lawyers in this case?

A Before --

Q Before the filing.

A -- the onset of the filing of the lawsuit? I don't know particularly what their contacts may have -- there contacts may have been. I'm not that involved in day-to-day work.

Q Do you know if they had contacts prior to the filing of the lawsuit?

A I believe they did because, usually, the way that NCSC becomes involved in something is that the organization is contacted by people who are concerned about the situation, who live there. And the -- the Dover affair has been going on, I guess, for a long time before the lawsuit was filed. So it's general public knowledge.

Q Yes. Do you know any names from the Dover area that you're aware of?

A No.

Q Have you volunteered to provide this testimony or are you being compensated?

A I'm not being compensated.

Q Let me ask you, you've done an expert report in formulating that report, Kevin, what did you look over?

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A I looked over most of the references cited in the back. I spent probably most of the time looking at the book Of Pandas and People. And many of the scientific references I already knew fairly well, and they're cited there for general support for the things I'm talking about.

Q How about anything else, the pleadings or papers?

A No.

MR. ROTHSCHILD: Can you just -- objection -- describe what you mean by that?

BY MR. GILLEN:

Q Sure. The complaint, the answer?

A I received copies of those. So I was generally familiar with what was going on that led to the complaint.

Q Did you review that in connection with preparing your expert report?

A I looked over it. The focus of my report, I think, is trying to analyze the role of Paleontology vis--vis science in general. And on the other hand, Intelligent Design Creaticnism as an alternative to science.

Q Yes. I mean, I agree. That's what I get out of it also.

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Now about, did you review the answer that was filed in this case in connection with preparing your expert report?

A I looked it over.

Q Anything else?

A I just had the complaint and the response.

Q Okay. Apart from plaintiff's counsel, Mr. Rothschild, and anyone else on the plaintiffs' side, have you spoken with any other persons in connection with formulating your opinion? Let me --

A When you say "other persons," do you mean other legal counsel?

Q No. Other people at Dover Area High School, for example.

A Oh, no.

Q Haven't spoken with the Biology teachers there?

A No, I haven't.

Q How about other people at the NCSC?

A Yes, I have.

Q Who have you spoken with there?

A I have spoken with Dr. Eugenie Scott and with Nick Matzke. And also, briefly, with Glenn Branch.

Q Did they provide you with any factual basis for your report?

A I don't recall that they provided any factual

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basis because they are not Paleontologists, and I am. But I did want them to see whether this -- whether what I was saying made sense to a reasonable person who was not a Paleontologist.

Q Okay. So if I try and just get a sense for how you have made an assessment of what's going on in Dover Area High School, what's the basis for your knowledge about the events at Dover Area High School?

A The account that was -- that has been reported through various media, including the popular press, my understanding is that there was an attempt to introduce Intelligent Design Creationism into the Dover School curriculum as an alternative approach to evolutionarily biology. And that, to this end, the text Of Pandas and People was going to be recommended or used in class.

Apparently, 50 copies of the book were at some point donated to the school library. There was a statement that was to be placed in the curriculum about the consideration of ideas, other than evolution, such as Intelligent Design. And that, eventually, a statement was read in the public schools by administrators, apparently because the teachers refused to read it, stating that -- that the idea of evolution had problems, and that there were other ideas, and that people should be open minded. And it was read to the

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students by the administrators, and that was it.

Q Is your opinion, your expert opinion, premised on that particular sort of factual basis or is it just one that's more generally directed to the role of Paleontology and addressing Intelligent Design Theory?

MR. ROTHSCHILD: Objection. You can answer.

THE WITNESS: Gee, those are two kind of different questions.

BY MR. GILLEN:

Q Yeah. All right.

A I think they're both fair, but I'm not sure whether there were four questions.

Q Okay. I can see that. Go ahead. Tell me why you see them as different and answer them to the extent you can. I'll try and clarify.

A Is your first question whether I think Paleontology bears on the introduction of Intelligent Design into classrooms?

Q Well, I guess what I'm asking is, I've read your expert report. It has this detailed and sophisticated analysis of the way Paleontology speaks to some claims that are made by proponents of Intelligent Design Theory, that's what they call it. I understand that you quote 'Intelligent Design Creationism.' That's one -- that's certainly the main thrust of your opinion

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insofar as I, as a layman, can make it out.

Then there's a series of other issues in this case that relate to, you know, sort of the practical result of the process, what actually happened. And I'm trying to get a sense for your expert opinion and what it's primarily concerned with. It seems to me, it's primarily concerned with the former. That is, sort of the intellectual discussion about the way in which Paleontology relates to the claims of evolutionarily biology, but not so much to the actual situation in the schools. Is that accurate?

MR. ROTHSCHILD: Object to the characterization. Particularly to the extent it's inconsistent with the content of the expert report.

You can answer.

THE WITNESS: I would say that I'm working at two levels in this report. First, as a scientist, and second, as an educator. I've taught at Berkeley for 25 years. Before that, I've taught high school, sixth grade, seventh grade science. I -- so I suppose I've been teaching since -- well, well over 30 years. And I've worked a lot with teachers in this state on science education, and what the quality of that education should be. I was involved, as you know, with writing this 1990 state science framework, which took really two years to

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do. And I've served several times on the evaluation of instructional materials, textbooks and things like that for K-12. And I do a lot of textbook reviewing, as well, for, you know, just people just ask me how does this sound.

So as an educator, I'm functioning also as a scientist. So the question that I'm really addressing is, would this be good science and would this be good science education.

Q That's exactly what I was trying to get a sense for, just at the outset.

When I look at your credentials and report, it's evident you're highly credentialed in paleontology. I wanted to ask you, just in terms of your training, have you had instruction in molecular biology?

A Any instruction that I had in molecular biology, formal instruction, would have ended with my doctoral dissertation in the 1970s. And molecular biology changes so fast, that I can keep up with it with departmental seminars and reading. Just like everything else, you know, your formal instruction ends at some point, and then you pretty much have to keep up with things as best you can.

Q Would you consider yourself an expert in molecular biology?

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A No.

Q How about the same thing, its -- from your report, its evident there's some aspects of statistics probability theory. What training do you have in that?

A I'm not an expert.

Q You mentioned that California standards for K through 12. Are there standards that speak to instruction in biology?

A Could I distinguish between the standards and the framework those are two different -- there's -- the names are so confusing.

Q Okay.

A The framework is put together about every seven years. And it's a book length document that explains what science is, how it should be taught. It explains the concepts that should be laid out at all the grade levels, and tries to explain how they should be interwoven into a general picture of science.

The State's standards are -- that's a different document. And those tend to be more specific in terms of what sorts of concepts are discussed and their details.

Q Okay. If I can, I'm just going to mark a copy of your report as Exhibit 1.

(Defendant's Exhibit 1 was

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marked for identification.)

BY MR. GILLEN:

Q Kevin, I'm going to show you a copy of something that's been marked as Exhibit 1, and ask you to look it over. I think you'll see it's another copy of your report, which I'm just marking for the purpose of reference in this deposition. It begins with the cover page, which is page 1, and you've mentioned the California Science Framework, K through 12. Is that the project that you were just describing?

A Yes.

Q I just want to get a sense for the difference between that framework and the standards, and how each speaks to the dispute that brings us here, which is this teaching of evolutionarily theory and biology. Can you give me just a short, if you will, overview of the way in which the California Science Framework speaks to instruction in evolutionarily biology, and particularly, whether it prohibits the teaching of Intelligent Design Theory?

A The framework that I worked on was the one that came out in 1990.

Q Okay.

A Intelligent Design was not on the map then. It did not specifically address Intelligent Design.

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Q Has it been -- has a new addition of the Science Framework been --

A Yes. It was released a couple of years ago because these are done every seven years.

Q Did you play a part in that process?

A No.

Q Are you aware of whether that specifically addresses instruction in the Intelligent Design Theory or --

A I'm not -- I'm not aware that it does.

MR. ROTHSCHILD: Can I have a standing objection to the term "Intelligent Design Theory"? I think it's one that the witness probably wouldn't agree with, but I'm not going to quarrel with you using the term, is my standing objection.

MR. GILLEN: Certainly. Certainly, I do understand that.

BY MR. GILLEN:

Q When this was authored, Kevin, there was creationism in the air and some disputes relating to the teaching of creationism in connection with evolutionarily theory. Did your Science Framework address that issue or the issues that surround the -- this clash between evolutionarily theory and creationism?

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A I don't believe it did directly, Pat. The -- we tried to focus on what was good science and good science education. Not on what was non-science, anti-science or poor science. We tried to -- we devised, with the Board of Education, a statement that appeared that was very prominent. In fact, we drafted this before the framework was even written. We agreed with the Board to submit a statement that explained that nothing in science, or any other field, had to be believed or accepted in order to be taught. To be educated, you had to be aware of things. But it didn't require belief in anything. And that, we hoped, would defuse some of the controversy that people felt about if I teach this in science, an I contradicting personal beliefs about things. And our statement is simply, well, you know, education doesn't compel belief, only understanding.

Q Let me make sure I understand you. Was the statement designed to address concerns brought to you or others involved in the part by teachers about teaching evolutionarily theory and the way it was received?

A That's part of it, but also, we knew very well of anti-evolution activities in the State, including creation science. People who simply didn't want evolution taught for various reasons. Largely because

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they felt it was against their religious beliefs.

In the State of California, you were not allowed to opt out of a class because you don't agree with what's going on. In fact, I believe in science classes, it was, and may still be, the rule that you don't have to be present for a dissection. I think that's the only thing you can be excused from.

Q So there is an opt-out with respect to the classes that instruct in biology?

A No, there's not.

Q There's not?

A Only -- I think dissection is the only exception. You can't not attend a class simply because you know it's going to be on something you disagree with, or you think you disagree with.

Q Okay. I'm not understanding you. Is there an exception for this instruction, this subject?

A No.

Q Okay. Okay.

A In other words, if you objected to a class that was going to be given on green house or earth warming, something like that, you couldn't absent yourself from class on the grounds that you didn't agree with what was going to be said.

Q Okay.

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A And we wanted to -- we wanted to put in the framework what was good, accepted science, that is science accepted by the scientific community so that teachers would be able to point to it and say, look, this is what I'm supposed to teach. You know, I may not agree you with, you may not agree with it, but this is what's accepted by the scientific community and the community of science educators. So there would be support, clarity, consistency.

Q Okay. So the statement was designed to help public education teachers deal with this culture?

A That's right.

Q Let me ask you about the standards. The standards that are currently enforced now, are you aware of whether they speak to the teaching of Intelligent Design Theory in class?

A I don't remember if they do, specifically. I did not play a strong role in the drafting of the standards. And my impression is that they don't, but I haven't looked at them specifically with that in mind.

Q What do the standards do, if you can tell me, do they layout specific objectives for each course of instruction?

A Yes, they tend to do that.

Q Do they do anything else? Do they give course

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objectives?

A They might do. I haven't looked at the final document.

Q Okay.

A Well enough to tell you whether that would be a good characterization of it.

Q Okay.

A In all, perhaps the sum total of the curriculum that they provide does, in fact, do that by virtue of what it says.

Q They're a public document?

A Yes. It would be on the web. And, you know, I don't have a paper copy of it. I just tend not to sit in front of a screen all day.

Q That's quite all right. I'm just trying to figure out how they relate in light of your earlier comment. That's all I want to see if they bear on some of the issues in this case.

When you're -- for the California Science Framework, when you employ the term "teaching," is there any specific meaning you give that term?

A Teaching in the sense of explaining what is in the curriculum, I suppose, would be the best. But, my gosh, there's so much more to teaching. It's understanding what students come in with, understanding

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how, as a group, and how individuals, they will best learn or respond to what you're trying to teach them. Trying to work with the prior knowledge of 30 different kids in class and their own behavioral and hormonal, and just personality differences. Teaching is so much more than just explaining material.

Q Yeah. Plainly, it's an art.

What I'm to trying to get at, though, is there a specific sort of pedagogical meaning that's attached to it like classroom instruction?

A Well, most teaching at the K-12 level, and at the college level, is based on classroom instruction. The 45 minutes a day or the three hours a week, you have students in front of you, but teaching also occurs in office hours. With my graduate students, it's 24/7. Every time -- all the time we're in there, we're all teaching and learning from each other.

Q Okay.

A It gets very fluid in the upper grades.

Q All right. Let me -- I'm just going to -- if you'll look at your report, I'm trying to understand what -- some of the details. And that's not so easy for me as a lay person, particularly one not schooled in science.

The section B is headed paleontology as

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Science. And plainly, status of science is important to this case. I know very well that you have devoted your considerable talents to paleontology. And what I want to get a sense for is, plainly, you regard it as science. What makes you regard what you do, as a professional, as distinctively a scientific endeavor?

A We collect information, facts about the life of the past. That is sort of the purview of paleontology. That life includes zoology, botany, any other subjects that happen to focus on things that are now dead and have been for a while. And our subject is that great phone book of life that's existed in the past for which we have some remains that are -- that are excavated from rock deposits in the earth. And these specimens tell us about the life of the past, how it changed through time, how it is ordered through time. The different organisms that lived at various intervals in time. How they functioned in their environments. What the patterns were by which different groups in the past waxed and waned, ultimately coming to form the tio that we have today.

Q And I understand that. I can see that you're looking at sort of an empirical set of data facts, and you're bringing to bear principles of certain disciplines you mentioned, zoology and so on. But what

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I'm -- you know, for me, as someone on the outside, I'm trying to understand the distinctive features of paleontology that you believe make it scientific.

MR. ROTHSCHILD: Objection to the form. You can answer.

THE WITNESS: The distinctive features of paleontology. Gee, they really don't defer from many other scientific fields like zoology, botany, insofar as they concentrate on a subject. In ornithology, it's birds. Of course, in botany, it's plants. In paleontology, it's -- can be both birds and plants, but it's just extinct ones.

And so our approach is to gather information and to form and test hypotheses about how these organisms lived in the past and how that changed through time.

Q And I think that last part of your answer helps me get further towards what I'm trying to grasp, which is, you say, "to form and test hypotheses." If we look at the methods of paleontology, are there certain methods that you believe make it distinctively scientific?

MR. ROTHSCHILD: Objection.

THE WITNESS: It depends on what question you're asking. Paleontology is, of course, more than just going out to the Badlands, finding a skull of a dinosaur, digging it up, and bringing it back. In that respect, it probably differs from botany, zoology, molecular biology, in that work might be done in the forests and the fields or the labs, more so than in going out to the rocks and looking for things.

That's not a question of the method of science or it's approach. That's simply a question of its material basis. It's where we find it. The molecules we can best get at in the lab. The plans and animals we can best go out to the field and collect them or see them or watch them. And in our case, we go out to the exposed rock terrains and we collect them. But it really depends on the kinds of questions that you're asking. If I'm asking questions about what are the relationships of fossil animals, I'm using the same principles that a botanist or a zoologist would use, and the same methods. It's just that our organisms are different.

BY MR. GILLEN:

Q Okay. And that's precisely what I'm trying to understand, which is what are -- in a case like that, which you posited, what are the methods that you're using which are similar to those of a botanist?

A If I were trying to find the relationships of a group of extinct animals that I work on, dinosaurs, horses, whatever it might be, I would use methods such as phylogenetic systematics, p-h-y-l-o-g-e-n-e-t-i-c, systematics is s-y-s-t-e-m-a-t-i-c-s.

Q Nothing like an educated witness.

That said, what else? What other tools would you use, Kevin?

A If I were trying to study the functional morphology of an extinct animal, I would use the same principles of comparative anatomy and motion studies, for want of a better word, we call them kinematics, k-i-n-e-m-a-t-i-c-s, that are used by zoologists. The difference being that they can put their animals on treadmills, and they can take films of them doing what they do. And we basically have to work with the joints of the bones that are left.

Q Okay. And that is some examples. I was struck by this part of your -- this Section B of your report, which said: To ask intelligent questions and determine reasonable answers requires knowledge of fossils of comparative anatomy of geology systematics, and so on. And then as I read the report, I noticed that there's -- in several places, you say, you offer sort of reasonable inferences in a number of areas.

And that, Kevin, is what I'm trying to drive at. Does your endeavor, as a Paleontologist, consist in just trying to do that, trying to make reasonable hypotheses and evaluate them against the empirical evidence that's available?

MR. ROTHSCHILD: Objection to the form. You can answer.

THE WITNESS: I would guess that's a lot of it. We form and test hypotheses about the relationships of organisms, about how they worked in their environments. We describe the life of the past, new things that we find. We look at where we lived and how they may have spread over various continents and oceans through time. We're basically reconstructing the life of the past by accumulating data, discerning patterns and trying to infer processes that account for the change of life through time.

BY MR. GILLEN:

Q And let me just -- I'm going to ask you a few things quickly and see if you can help me. I'm just trying to get a handle on the way in which your discipline works.

On page 1 of your report, you pose a question, what are the relationships among groups of fossil organisms. In your day-to day work as a Paleontologist, how do you go about trying to answer that question?

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A We look at the preserved features of the organisms. In the case of things I work on, it would be features of the skulls and other bones of the skeleton, which are usually mostly what's left in the fossil records. And by looking at those features, we find what systematics calls synapomorphies, which is a word that's spelled s-y-n-a-p-o-m-o-r-p-h-i-e-s. It's a funny word, and it means shared derived characters. These are features that are unusual compared to other animals or plants. They are things that are novelties compared to other animals and plants. And why we look for these features follows simply from a premise about genetics. And that is, that organisms inherent characteristics from their parents, and they pass them on. And so when a new feature appears in a lineage, and it's passed on to its descendants, then we use that new feature as a mark of more recent common ancestry than with other organisms that don't have that feature.

It's a little confusing, but it actually results in a very interesting hierarchical pattern. If you have, for example, five organisms that you're comparing, and two of them share six features that nobody has, and the next one added to them -- shares five of those features, and the next one out shares four of them, the next one out shares three of them, and so

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on, ultimately, you're watching the sequence of these new shared derived characters that appear. So you have actually a hierarchical arrangement of the order in which these things would be related to each other. Does that make sense?

Q Yeah. It does somewhat. I mean, it's difficult to follow, but that's what I'm trying to get at. Is there any other way in which you go about finding those relationships?

A No, that's --

Q The principle --

A -- that's the principle of phylogenetic systematics.

Q Okay. Again, in your report, you ask the question, how do mechanisms of developmental biology help us to explain morphological diversification of structures in plant and animal evolution.

Now, when you look at that question, Kevin, what is the method or the method you bring to bear on that question?

A We often look at how structures in living organisms develop. We can -- we can have a much better idea of the development of living animals than of fossil animals because embryology of fossil animals is difficult to come by, particularly early stages. They

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don't preserve very well. And so, when we ask questions about, for example, which digits are these three digits of the bird's hand, or where did the bones in the middle ear of mammals come from. Sometimes by looking at the development of living animals, we can see whether fingers are lost or begin to form and then stop forming or how bones migrate from an area around the jaw into the ear. And that gives us some clue about whether that could have been the process that evolutionarily caused that change to happen.

Q Anything else you used to try and make that -- answer that question?

A There are some sophisticated new techniques in developmental genetics that actually trace the expression of a gene in different structures, which then can be labeled and seen to be the same in two different organisms, even though they may appear to do different things, or their form is somewhat different.

Q Is that something that Paleontologist use?

A Paleontologists do use it. Some of them even work in developmental genetics and do this work. Many developmental geneticists also work with Paleontologists to try to solve some of these problems. One of my graduate students right now, for instance, is looking at the formation of something called the neural crest.

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Neural is n-e-u-r-a-l. Crest, which is a tissue that forms early in life and it's responsible for forming many of the tissues in the body. And she's working on whether the turtle shell and the bones that are in the back of crocodiles, the kind of hard armor that crocodiles have along their backs, is actually produced by the neural crest. And to do that, she has to work in developmental genetics.

So, yes, I guess, I would have to say that Paleontologists are increasingly working in these and other disciplines.

Q You mentioned the mechanisms of developmental biology. When you use that term, what are you referring to?

A I'm referring to the general field that examines how specific genes influence functions of the development of structures that later become part of the adult body.

Q So I'm not sure, is that genetics? Are you saying it's essentially the focus on genetic change?

A Yes. It is how genetic change influences the formation of the structures.

Q Okay.

A In other words, morphology.

Q That's what I was trying to get at.

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When you -- do you have an opinion, as a Paleontologist, as to what that sort of that mechanism of developmental biology is that produces the genetic change?

A Do I have an opinion as a Paleontologist of what that is? It's -- we understand it as gene function.

Q Okay.

A But I guess maybe I don't understand the question.

Q When you reference the mechanism of biological change, I just want to make sure that I -- I'm looking at that term the way you do. And that's all I'm trying to understand. Is it essentially, as you say, the biological disciplines understanding of genetic change through time?

A Yes. It's completely consistent with that, as far as we know. We know that genes vary in populations. We know that in lineages and related species, there are different genetic constitutions. And this discipline focuses mainly on how specific genes determine specific functions that then influence these changes in form.

I'm sorry. I'm trying to speak as -- to explain it. I'm trying not to over simplify it, but to use words I hope --

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Q That's all I'm trying to do to. I appreciate any effort on your part to simplify what you do day-to-day. That's totally appreciated.

What I'm trying to get at here is my sense that when you refer to the mechanisms of biological change, you are -- sort of, your discipline, which strikes me as profoundly sort of interdisciplinary, is borrowing in that area from the biological sciences. And when you reference, therefore, the mechanism of biological change, you are referring to genetic change through genetic mutation, and then heredity. Is that accurate, Kevin?

A Yes. That's -- and you're absolutely right. We have a very interdisciplinary science.

Q And that's -- and then my next question then is to try and get a sense for the several places in your report where you have this -- you're taking issue with the notion of randomness. And on the one -- I'm trying to understand that. And let me see if I can tell you what I think, and then we can talk about it.

It seems to me that, from what you said, that genetic change is random, random mutations, but when you get to selection, it seems that you have a very definite conviction, as a Paleontologist and a scientist, that that selection is not random. I want to see if I'm

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apprehending your position correctly and then just have you explain it to me a little more. Is that accurate, Kevin?

A I'm sorry, no.

Q Okay. Tell me why.

A Selection is the opposite of random.

Q And I do understand that.

A Okay. So that if we had random admission to university, it would be very different than if we selected people on the basis of various features that -- and --

Q But -- excuse me, because I don't want to waste your time, or anyone's time here. We have the genetic changes, right?

A Yes.

Q And then it seems that, based on your report, if I'm understanding it, then there's a selection process. I'm just focusing right now on that genetic change. And I'm -- it seems to me, based on your report, that when you're describing that facet of the mechanism of biological change, that is random; is that correct?

A Let me explain it slightly differently. When we say something is random, it's a probabilistic statement about -- about the distribution of certain

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cases in a population. It does not mean that the causes are random. We may understand very well what the causes are of some kind of a change. We may still not know which individuals in a population would be affected in advance of this actually happening.

I believe I used an analogy to -- I'm not sure if I did in this report. I'm sorry, Pat. Let me give you an analogy. We may say that 353 house fires occur in California each year. If -- and we know why they're caused, arson, smoking in bed, lava lamps fall over, whatever. We have a good idea that maybe that pattern has been 350, roughly, for a long time, where it's a rate of 350 in the population, you know, maybe grows with the populational rate, that's fine. But we don't know in advance which houses are going to burn. If we did, we wouldn't need insurance. And when we talk about random effectively, we could say, well, house fires -- or the instance of house fires is random, but it's not in that case because we know that they each have a cause. They just don't happen. It's just that we can't predict which ones will be there in advance.

Now, let's say we have a simple genetic mutation of white-eye in a fruit fly or something. Just -- not very important thing, just a little -- and that on the average, may be about six in 100,000 might

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have this white-eye difference. We might or might not, and I don't know fly genetics enough to tell you, we might or might not know the gene function that produces that white-eye. We may know which gene does it, even if we don't know what the function is. But we know that that change itself is not random. We simply know that the -- which particular individuals in the population will have it, is random. And if we have a rate of six in 100,000, we may have eight one year and three the next generation. But that's the meaning of random to a scientist, as I understand it.

Q And I understand that, and thank you. I'm just trying to get a sense for -- let's keep with the fruit fly. The first instance of the gene that produced the white-eye. If we look at the mechanism for that change, is that random mutation or do have some other understanding of how the biological sciences address that initial mutation that produces a change in a given species, in this case, the white-eye in the fruit fly?

A It's a change, but I don't think it would be correctly characterized as random. We know that a duck's head isn't going to pop up on a horse or a trout. So in a sense of anything can happen, that's not our understanding of random. And when, you know, your kids come in and say, oh, like that's so random. They

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don't -- they're talking about it like it came from nowhere. Somebody just seemed to say something that was a non sequitur. And so our common understanding of words like random are real different from what we mean in science. And my understanding of random, as a scientist, would not apply to causal factors, but rather to distributional factors in populations.

Q Okay.

A For example.

Q Okay. Then just let me understand here if I can. Are you saying that there's no such thing as a random genetic mutation?

A When applied to causality, I would say I don't understand how the word "random" is interesting or applicable there.

Q And by that --

A Although we talk about it all the time, don't we? And what I think we mean is the incidents in populations.

Q So again, just to make sure I understand you, is it your view that any genetic change is not random?

A I would agree with you in the sense that it is all determined by biochemical causes, genetic causes, things that get down to the genetics -- that determines structure.

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Q Okay. So then when you look at -- you say -- when you say natural selection is the opposite of randomness, explain then, what, to me, please, so I can understand you, what are you getting at there, what is -- why is natural selection not random, in your opinion?

A If you have a population of organisms, they might be -- they might be mice, let's say, living out in the field somewhere. Darwin's idea was that some organisms, some individuals, would be more fit than other individuals. And that the ones who would be better able to live in their environments escape from predators and so forth, make more efficient use of food resources, and so forth, would be the ones more likely to survive to the next generation. And to survive perhaps longer to produce more offspring so that those same features that this organism had would be passed on to the next generation. That's his idea of selection.

Random would be those same mice living in a field and a tree falls and kills 50 of them. And the 50 that it kills are -- have no real fitness component about them. In other words, it's taking everybody regardless.

When the plane crashes, it doesn't matter whether you're a -- you know, the Pope or the president

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or, you know, just some normal dumb guy like me. It just -- that's what happens when you happen to be on that plane when this happens. So that would be non-selective. That would be sort of a random culling of the population in that sense, because it wouldn't be correlated with any selective factors that have to do with the organisms themselves. Rather, they were unlucky.

Q So am I understanding you correctly that, essentially, you believe natural selection is not random because it's positing a causal connection between the attributes of the given species and its ability to survive?

A Just so.

Q Now, but that just -- and in positing that relationship, you're -- it entails positing both an advantage or feature of a species and then a way in which it would confer an advantage on the members of that species with that characteristic; is that true?

A That's the idea.

Q Okay. And is that why, Kevin, in your report at several points, you make this very clear, selection is the opposite of random. Is that what you're getting at there?

A Yes.

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Q Just so I can understand it, it's a notion that there's a causal connection between the feature and survivability as opposed to, as you say, the tree falls. It had nothing to do with who or what you were and what your attributes were, it's just bad luck?

A That would be the idea.

MR. ROTHSCHILD: This is a good time for a break?

MR. GILLEN: Yeah, it is.

(Recess.)

BY MR. GILLEN:

Q Kevin, this is -- all the questions I've asked you so far, I'm trying to just make sure I understand this process as you do, which -- just in its rudiment. What I'm looking at is the statement like this at the bottom of page 2 of your report that carries over. You're talking about Darwin's view, and you say, he was not talking about how major new adaptive changes took place; he was talking about how minor variations could be selected upon by natural forces to produce heritable evolutionarily change.

And there's a couple of elements to that sentence that have to be impacted to a layman like myself. The first is the minor variations in the species. Am I correct in that when you, as a

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Paleontologist, look to those minor variations in the species, you account for them with reference to biology, more specifically genetics?

A When we see variation in a population of organisms, whether its living or fossil, there are two basic causes of that variation. One is genetic, and one is environmental.

Q Okay.

A So a stunted population of trees might be stunted not because their genes make them short, but because their environment is harsh and it's tough to grow.

Q Okay. And if -- so of those two possibilities for the minor variations, we have one that's genetics or internal, and then there's another that's external to the subject, the specimens; is that accurate?

A Yes. One is heritable, and the other one isn't.

Q Okay. And for the purposes of -- well, Darwin's theory, we're looking at the heritable?

A Yes.

Q Now, selected upon by natural forces. I think you gave me some good examples of that earlier. That's in ways in which the surrounding environmental factors give rise to a causal relationship between the features

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of the species and the environment which confers an evolutionarily advantage on the species with a specific trait; is that accurate?

A Yes, more of less. Some individuals are going to be more favored than others.

Q All right. And then produce heritable evolutionarily change. Just to make sure I understand what you're getting at there. It's that notion therefore, because of these -- this advantage, it's more likely that species with the advantage or members of the species with the advantage will pass it on in the genetic matter of their offspring?

A That was Darwin's idea.

Q Okay. Now, then you say, when you go on, you say his main concern, Darwin said this, was with the mechanism of natural selection, which cannot be observed directly in the fossil record. Now, I wanted to make sure I understand that. Again, the mechanism of natural selection. Is this the relationship between the feature and the environment or is it the genetics or a biological component of the process?

A It's the process by which the composition of a population changes from one generation to the next based on factors that make it more fit for its environment. That would be selection in that sense.

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And when I say that we can't observe this in the fossil record, what I mean is that we can't observe generation-by-generation full populations, we can't take their genetic constitution. We don't have a complete enough sample. So when we look at the action of selection itself on a generation-by-generation basis, that's much better than done in field and laboratory studies today. And a lot of that work has been done.

Q That's what I was trying to understand. You're getting at there that the fossil record, as it exists today, is insufficient to wholly grasp this process you've described. Is that your point?

A It's insufficient to measure the generation-by-generation selective factors. What it does measure, is the overall effect of selection on populations through time, which -- one of which we call adaptation. And so, we actually identify the action of natural selection through the proxy of watching -- of watching adaptations evolve in lineages through time.

In evolutionarily theory, adaptation is defined as the result of natural selection. These are features that are improved behaviors, functions that are improved through the action of natural selection, which is again this rubric, r-u-b-r-i-c, that encompasses environmental factors, factors of competition, predation, interactions

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with other organisms to shape succeeding generations.

And there's also an element of opportunity, that is, organisms often change evolutionarily because they're able to make use of a new feature in their environment that wasn't exploited before, and a lot of that is what we see. So when we look at the adaptive improvement of structures in a lineage through time, we're -- we are making the inference that selection has done this. But the generation-by-generation measures of selection are done in populations of animals in which, for example, we're watching much more small scale adaptations, not the ones that takes millions of years.

Q Okay. Let me make sure I'm following you here, to the extent I can. First, it seems, based on your answer, that when you say you're looking at the mechanism of natural selection, we're sort of -- it's prescinding from paleontology trying to locate or prove out this sort of genetic component of the process, that's kind of taken off the table; is that accurate?

A We can't examine the genetics of the fossil populations in that same realm, which is right.

Q Then you say, you observe a population through time. I think you said using adaptation as a proxy --

A Yes.

Q -- for selection?

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Now, if I may, Kevin, are you saying there that if a feature persists through time, you infer that it has conferred an advantage, that it's been selected, so to speak, or --

A I'm more talking about cases in which we see the emergence of a feature that has a demonstrable functional behavioral role. If this is -- if this is persisting, and even improving or elaborating through time, then we presume that there is some sort of selective role. There's some sort of advantage to this feature. And that, as we say in our common parlance, selection is maintaining or shaping that feature.

Q So the underlying inference is that adaptation which persists confer advantages, are a positive addition to the species?

A Yes.

Q At the end of the section D, you have a sentence that says, "The fossil record provides strong support for evolution, and has since the mid-1800s."

Is it proof along the lines that you've suggested thus far this morning, Kevin, this notion that you can watch a pattern of certain adaptations and endurance through time on the part of certain species, is that the evidence.

A Both those things and more.

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Q Okay.

A People in the early 1800s, and even slightly before then, recognized that the fossil organisms that they found in rocks were not uniform from place to place and from -- as you went up a rock column either in one place or stacking them by correlating them from one place to the next, because they are the same things over here and then there's more beds below them, and they can be inferred to be below the ones that were over here and so on. Those -- those fossils, the farther down you went, the less they resembled the organisms of today. Some of them had no present day counterparts at all. Some of them were enormously successful like trilobites in rocks that are very, very low in the available section, which people came to realize were very, very old.

And so, we see these patterns of waxing and waning of replacement of some groups by others as -- as the whole support for what used to be called the progression of life through time. That progression could be explained by any number of ideas. The idea that in the early to mid-1800s was given to support it was evolution. That is, that things were changing through time. And some things were disappearing, and some things were forming anew. And that these often

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resembled things that were already in the preceding sediments. So the whole idea of biological evolution was actually well in the year before Darwin wrote a word.

Q Okay. On page 10, Kevin, where you discuss about Pandas and paleontology, there's a line in here that I just want to make sure I understand. It's the second full paragraph under subheading C, and it's about halfway down the paragraph. And it reads, "The origin of major new adaptive types and major groups of organisms begins with a single speciation event of very few minor structural changes."

Now, it seems to me, from our discussion this morning, the speciation event is the province of the genetic facet of the process; is that correct?

A No.

Q Okay.

A Recognizing different species is not solely a matter of genetic difference.

Q Well, what accounts for this?

A We actually recognize species by different criteria. What we call a species is a lineage that is distinct from other lineages in essentially time and space. How do we know these things are distinct in time and space? We have a series of criteria. For organisms

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that interbreed with each other, we find that if they can no longer interbreed with each other, then they are separate lineages or species.

Sometimes organisms could potentially interbreed with each other, but they live in -- they've wandered off into different places. And so effectively, they're not going to do that any more.

Sometimes they may live in close proximity, but ecologically, they're doing different things, so they don't encounter each other so often. And there are other ways that people look at this. So the formation of species themselves is a process that goes beyond simply a genetic assessment to an assessment of how the organisms live in the world.

Q So am I correct that there's -- your answer points to two possible sources for a speciation event? One is genetic. The other is environmental in the ways that you described in that the populations can be so distributed that they're no longer going to be considered as one species. Is that accurate, Kevin?

A The words you started with, it can be both genetic and other means. Again, I think that our characterization is one of lineages that are separate. They may have genetic differences. Certainly, they probably will to a greater or lesser degree. Sometimes

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they have very few. But it mainly is a question of, are they separate from each other, do they prefer organisms that interbreed, do they interbreed with each other.

For example, we have a concept called sibling species. And sibling species are those that you can't even recognize if you just put two individuals on the table. Two beetles, for example. You may not be able to tell their difference at all, or two crickets. And they tell their difference because they have different mating calls. Or -- so, for example, the two crickets may live on the same Hawaiian island right next to each other. But the one will have a mating call that its females will recognize, but the other females won't.

The two beetles may be perfectly alike, except one will breed two weeks after the other. So they will actually never come into contact again, but they still look the same. These are, for all intents and purposes, separate species, lineages through time that are now no longer the same thing.

Q Well, what accounts for that kind of event, that speciation, I guess you call it?

A Speciation. What accounts for it? Well, some speciation probably has an adaptive basis. That is, let's say you have several populations of a plant and those plants are distributed and some of them eventually

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acquire their way from the flatlands up onto the hillside where things are a bit -- life is a bit tougher, let's say. There's a shorter warm season, the winds may be more severe, the soil may not be as good. And yet, these populations are adapted to live up there, they're happy, they're doing fine.

Ultimately, they may become so genetically different from the ones down on the flats, but even if you transplant them, A, they won't do well. And if you try to interbreed them, then don't interbreed with fertile offspring. That's the classic model of the species difference that we would call adaptation.

Q That's a genetic?

A It eventually acquires a genetic component to it.

Q Through the selection due to the environmental factors?

A Yes. Selecting on particular genotypes through selecting the phenotype that are more adapted to this new environment. That's the classic mode of speciation that people think about.

Q Then again -- I'm just -- on page 10 here, you say, 'A speciation event of very few minor structural changes.'

Now, there, Kevin, are you referencing -- are

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you referencing in this sentence, 'The origin of new major adaptive types and major groups of organisms begins with a single speciation event of very few minor structural changes.'

Is that a reference to genetic changes in the subject species?

A Well, it has a genetic component. But I think maybe we should focus on what we call the phenotype, which is the appearance of the organism and it's behavior and function. This is where the rubber meets the road evolutionarily. You can throw a lot of organisms out in the world with different genetic components. Who survives, in terms of when selection is acting, determines -- is determined by the whole phenotype and not an individual gene, in most cases. The gene will determine the phenotype. The genes will determine the phenotype.

So it's probably better to focus on what sorts of phenotypic or differences in form we can relate to. Because, as we've established, we're not doing genetic studies on long extinct organisms. We have their -- what's left of their appearances, their form, their phenotypes to work with.

So it's these few structural changes that people in evolutionarily biology who look at life on the

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long run, can work with to sort of see where big elaborate adaptation start, which is frequently from just a few structure changes.

Q That's what I'm trying to get. I'm trying to understand here. You described this process, these changes accumulate. Now, I'm -- what are you getting at there? The small structural changes tend to accumulate? Give me an example of that, if you would, so I can try and follow you.

A I'm trying to explain that when we have sequences of major adaptive change in evolution, the kinds of adaptive change that often separate whole great groups of organisms, mammals from their closest non-mammal relatives, birds from reptiles, how do we get across these gulfs? Is it all a sudden change and boom there's a full-fledged bird? No, that's not the pattern. The pattern repeatedly, as we come to have more fossils available to us and better means of analysing them, more complete interdisciplinary ways of looking at these questions, we're actually finding that these great gulfs that seem to separate living groups like that in a fossil record, we actually find features that close the gap much more than we could expect. And often in ways that we didn't predict.

Q And you use the term "features." And it seems

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to me, from reviewing your report, that you differentiate transitional features from transitional forms.

A That's a very good distinction. I'm really glad that you got that. Because that's a very important point that is lost on a lot of people.

Q And plainly, that's one of the issues here. I'm just trying to understand. It seems from what you said earlier, that if you watch a feature persist through time, you're regarding that as an adaptation?

A We regard it as an adaptation if we can identify some functional or behavioral utility. We can see it as an adaptation if we see it improve or change. For example, from something where there doesn't seem to be a specific function to acquiring this new function.

In other words, we can look at the -- we can look at the forelimb of the animals that eventually became whales, the earliest whales. And we identify them as whales, even though they're animals that are walking around on land like horses and cows, although they don't look like horses and cows. On the basis of features of their skulls and teeth that align them with later whales. In other words, these are basic synapomorphies of whales. As these early whales begin to go into the water more, which I can explain the whole

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detail. But as they go into the water more and stay in the water more, these limbs on the forelimbs, the hands become longer and more like flippers. Where as the hind limbs become much smaller and finally are unable to support the animal on land. These we would see as a change in these features through the lineage of whales that we would regard as an adaptation, because we know from functional morphology that a flipper-shaped fin is good for swimming.

Q Gotcha. Now, in that same sort of adaptation in another beast would not contribute to its ability to survive in its environment; and therefore, you would not regard it as an adaptation?

A We wouldn't see it on a horse.

Q Now, with transitional features, are you -- is your point there that you see the features in a number of different lines as opposed to -- in other words, what's the distinction between the transitional feature and the transitional form?

A That's a good question. The transitional features are seen in the lineage of organisms. Not ones that are completely unrelated to each other, but ones that are related to each other. And we watch these features changing in this lineage. The lineage of animals we find, let's say, we don't have to find a

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specific linear ancestor. It may be an uncle off the path here, but he may share these synapomorphies with all the later whales. And so, he'll tell us a lot about what the quote/unquote direct ancestors, which we may or may not find, actually were like.

Q So, Kevin, just so I understand, with -- when you make these judgments involving that funny word of shared features, how are you doing that as a Paleontologist, what criteria are you using to place some particular specimen or -- in a given family or line?

A Right. We're using the synapomorphies from all parts of the available material. By which, I mean the skull and the skeleton, all the bones that are available to us. For example, when I was talking before about the forelimb changing, we wouldn't just line up forelimbs in a sequence and say, that must be the way they evolved. We would have to look at all the characters of the skull, the teeth, the vertebrae, the ribs, the pelvic girdle, the hip, the hind limb, the feet, the tail. We'd actually -- we say code, and we mean specify the condition of those features, describe those features, and put descriptions, coded descriptions, of every one of those features into a big data matrix. And then we essentially ask the computer to sort out which things

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share the most synapomorphies.

In fact, if we're asking questions about the forelimb, we might even take all the forelimb data out of that matrix and just run it on the other things, okay, so that we have our answer; we have an answer that describes for us who is sharing the most synapomorphies in this group. How are these things branching off with each other and from each other? And then, we can, if we like, ask the question, well, what does that tell us about the changes in the forelimb through time? Are we seeing a single change from the simple standing leg to a big flipper or is the pattern somehow different? And the idea that -- the idea is that we test ideas about, for example, forelimb evolution, by comparing them to the distribution of differences in all of the features of those organisms. Does that help?

Q If not, it's not for lack of trying. Let me just try and understand.

A Sorry. It's really abstruse.

Q In terms of the process you described, and if we take the whale as an example, if I look at the way this classification is looking for shared transitional features and so on, works, is it -- So I understand you correctly, you measure, sort of quantify and classify the individual parts or attributes of the subject of

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your examination, and then you compare those. You've got classifications that are set out for each of these, the forelimb and other, the skull, the teeth and other parts, you load all the data, as you say, and then, based on a doubtless complicated sorting process, try and see the greatest overlap of features, which, in turn, points to the most likely lineage for that particular subject?

A That's basically it.

Q Okay. So the -- in that case, I guess, there's sort of reason judgement that's being made based on sort of the weight, the center of gravity, or the preponderance of what appear to be shared features. Is that accurate?

A The presumption is that the more shared new features that organisms have, the more recent their common ancestors have been. If two organisms share 46 of these things and they only shared two with somebody else down there, then they're presumed to be more closely related as an extreme example.

Q Sure. When you say "more closely related," there's obviously -- we focused on the feature comparison component of that analysis. Are there other components that you use?

A In living animals, increasingly. Analysis of

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the genetic material itself is used. So the DNA/RNA segments can actually be looked at. Specific genes can be sequenced. The specific parts of the geno can be looked at. And these comparisons, again looking for shared derived features of the geno, provide a tremendous wealth of information far beyond what we can get from the skeletal parts, because there are simply so many genes.

Q Okay. But then, again, you've got this fascinating portion of your report here dealing with the whales and whether they could have an aquatic or terrestrial ancestor. And the point of that, if I'm not correct, is that the molecular biology has its limits, also, in positing these lineages. It simply can't -- at least, if I'm understanding it correctly, it can point to a certain shared ancestry, but it cannot really pinpoint certain features of that shared ancestor at all?

A To the extent that genetic analysis is not possible for completely extinct animals, that's true. So for example, in the whale -- in the case of the whale, the most recent molecular analyses were telling us that whales and hippos are each other's closest relatives, which is really hard to believe for many people. Simply because they are so different. But of

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course, whales are different from everybody now. But if you go back 50 million years to the Eocene, they weren't that different from other kinds of hoofed animals running around, which also didn't look like hippos of today.

Hippos are only found in the fossil record for maybe 15 million years. Whales are first known over 50 million years ago. So we've got a 35 million year gap, where are the hippos. And it turns out that only fossils can tell us that hippos are members of a larger extinct fossil group. I won't bore you with the name. And that these guys are related to the early whales. But there's no trace of them in the living fauna. So molecular analysis couldn't assess them.

Q It cannot go back. As you say, you just don't have the genetic material needed to plumb that line?

A On the other hand, molecular analysis is correctly giving us two things. One, is the fact that hippos and whales are each other's closest living relatives, which is great. And the other thing is, that the degree of their divergents, the degree of their molecular genetic differences implies that they diverged from each other maybe 50 million years ago, which is about what we would calibrate from the fossil record just because they're genetically so different. So it

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really is telling us a lot of this.

Q In terms of the inference you can make from that?

A Yes. It's consistent, in other words.

Q And in terms of the role that paleontology played in making this judgement as to whether or not the original shared ancestor of the whale and the hippo was terrestrial or aquatic, am I correct that that judgment, in turn, rests on this process you described of tracing out the lineages based on shared features?

A Yes.

Q Let me ask you again, trying to understand the basis for your opinion here. At a couple points in your report on page 2, for example, you point out that Darwin was not -- let me see if I can find this. He wasn't principally concerned with new major adaptive types, that wasn't -- and you say that, I think, on page 2 and 3 and then later on page 10; is that correct?

A Yes.

Q Now, on the other hand, on page 5 of the report, when you're dealing with Intelligent Design Theory, or IDC as you call it, you're -- you dismiss the distinction that they make between macro and microevolution. What I'm trying to get at there, Kevin, is what -- on the one hand you seem to be recognizing

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that there's a distinction. And on the other, you're plainly somewhat disapproving of this component of Intelligent Design Theory. What are you getting at there, what is your --

A IDC supposes that the kinds of changes that separate major groups of organisms are not tractable to evolutionarily solutions. And so they posit that in these cases, there must be some other causal agent about which we know nothing, but it has an intelligence. And I think that scientists would characterize macroevolution not as huge changes, but rather as changes that occur in groups once you reach the level of species.

In other words, individual in a population is microevolution, changing from generation-to-generation. Once you get separate species, and you're talking about how those lineages behave through time, you're talking about macroevolution. And an example might be, let's say we have some horned animals, and that one group looks like the Impalas, and they have fairly simple lightly curved horns. This lineage, going back in the fossil record, seems to be pretty much Impalas all the way. Back 10, 15 million years in Africa, they look pretty much like Impalas. That lineage is related to another lineage that includes the Wildebeest, the

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Hartebeest, Springbok, things like that. There's a lot of them, and they have a lot of funny names. But they have a great diversity of horn shape. And they have been a much more successful group than the Impalas in terms of species diversity through time.

Macroevolution might ask the question, why should that be, what is contributing to the success of one over the success of the other, are they better at running, are they better at feeding, do they have better ruminant stomachs, or is it just that this head gear enables them to make more species because they recognize differences and form new lineages.

These are the kinds of questions that you can't ask by looking at individuals in populations. And there's nothing magical about it. We're still dealing with individuals who are changing and passing on their genes. But the phenomena are a little bit more large scale. And I kind of think about it a lot like economics. We have microeconomics and macroeconomics.

Q What -- let me ask you, is it -- it's not so much, in my understanding here, it's not so much the distinction between macroevolution and microevolution, it seems like that, in your opinion, there is a basis for that distinction; is that accurate?

A There is a distinction in the hierarchical

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level in which we're studying things.

Q Okay. One within the species, that's microevolution, and the other, macroevolution, would be changed between species.

Now, Kevin, is that what you refer to as a speciation event, those -- or the result of a speciation event?

A We would say that macroevolution is the interactions among species. We have to begin the discussion of macroevolution with the speciation event because that's what produces new species, as opposed to below the speciation level. We're talking about individuals in populations.

Q Let me ask you, when do you -- how do you make the judgement that's there's been a speciation event?

A When we recognize two organisms as separate species, which we do according to the criteria we discussed before.

Q So that's the interbreeding criteria, there's no longer interbreeding?

A That's one criteria, yes.

Q What were the other, there was nonrecognition, sort of?

A Exactly. There's ecological differences, geographical differences, sure.

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Q Okay. So am I correct then, that the objection here you have here on page 5 of your report, used -- related to the use of the terms "macroevolution" and "microevolution" by the proponents of Intelligent Design Theory, is based on what you said earlier, that in your judgment, Intelligent Design Theorists see macroevolution as intractable, as you put it, to evolutionarily solutions?

A Because they see it as an entirely different kind of process that creates big changes. That is not the definition of macroevolution that scientists use.

Q Okay. What is the definition of macroevolution, just so I have it down?

A I would define it as the study of patterns and processes in lineages of organisms above the species level.

Q So -- and that is, I think, what you're referring to in several portions of your report where you say how new major adaptive types emerge?

A Yes.

Q That's the subject of macroevolution?

A That's one of them, sure. Mass extinctions might be another.

Q Okay.

A And there are many other kinds of subjects,

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biogeographical change. For example, how marsupials got from North America to Australia and South America. Through time, these are important questions --

Q Okay.

A -- that we ask, yeah.

Q Again, those are either genetic or environmental?

A Functional.

Q Functional changes. I'm sorry, Kevin.

That account for a speciation event; is that correct?

A I wouldn't say they account for speciation events. They presuppose that species exist and they're often concerned with the patterns of how these species are deployed in space and time, the processes by which they get there or survive, and the mechanics of organisms that allow them to make a living and survive in their various environments.

Q And is your principal difference with the IDT -- short for Intelligent Design Theory, from here on out -- is that they don't -- they don't see that macroevolution as being accountable for by evolutionarily theory?

A Yes.

Q Whereas, it seems your opinion is that the --

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this level of macroevolution is really just a sort of a quantitative accumulation of microevolution?

A In many respects, yes. And I also -- and without contradicting that statement. What I want to say is that macroevolution studies a different hierarchical level of phenomena than microevolution does, microevolution being concentrated on the population level changes, and macroevolution being concentrated on higher levels of related groups and their environments through time.

Q And just again, this is kind of simple, but forgive me, I'm trying to follow you here. When you say that paleontology is providing support for evolutionarily theory, that's what you're getting at, is this observable pattern that you found here in the fossil record, in your opinion, demonstrates the result of the process of biological change in natural selection?

A That's a big part of it, yes.

Q What are the other parts?

A Well, the other elements of macroevolution that we haven't talked about include things like that, the documentation of mass extinctions. That's a big subject in evolutionarily theory that can only be assessed by macroevolution. It doesn't apply, of course, in any

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way, to the population level.

When you find a point in time where there is a substantial proportion of living organisms becoming extinct in a relatively short time, we identify those as mass extinctions statistically, actually, by virtue of what a big excursion it is from normal extinction rates. The study of mass extinction is another area of macroevolution that's very important.

Q Okay.

A But mass extinction is not really on the table for IDC proponents, because they're more interested in questions of how life evolves than it how it gets snuffed out.

Q In other words, am I understanding you there, since their focus is on trying to explain the mechanism of change, they're not, from a genetic standpoint, a biology standpoint, that find themselves less concerned with some of these environmental factors that you've pointed to, which can, if I understand you correctly, just as readily explain why a given species endures through time?

A Well, I'd say that their issue is more focused on origins than anything else. And origins is one part of macroevolutionarily study. And as we've seen, there's others. Such as extinctions, such as geographic

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change in the distribution of species. And yes, the change in their climate and things. And IDC is not really terrifically concerned with those things. They tend more to focus on the process of evolutionarily change itself and whether our understanding of this can account for the differences among organisms.

Specifically, what I'm taking issue with here, is the characterization of macroevolution. Because it suggests, A, that it must be a completely different kind of change. As you put it, genetic change, that is possible for them. Whereas, biologists don't seem to think. There's no evidence that says it's really different. It says that, rather, it's more a net effect of cumulative changes in a lineage in structure and function and behavior through time that result ultimately in differences that do seem to separate groups of organisms that once were fairly similar.

Q Does -- can paleontology prove that process you just described?

A If I could just say that I don't -- I think the word 'prove' should be reserved for mathematics.

Q Okay.

A But that's right.

Q Forgive me. I'm using it as a layman.

A No. Because scientists do -- many scientists,

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chemistry, physics, especially working on experiments, do talk about proof. I prefer to sort of use the term 'support' or 'establish' or 'demonstrate,' by which we mean that certainly our conclusions are open to modification, but it's a pretty good show.

Yes. I think paleontology can do this in many cases. Paleontology will broadly to incorporate elements of functional morphology, physiology, comparative anatomy, which is all the stock and trade of Paleontologists, even though they are also studied as separate disciplines.

Q Let me -- I'm trying to figure out the ways in which, when you look at paleontology and it sort of -- well, let me ask you this, can it prove or can it sufficiently demonstrate, to your satisfaction, sort of the mechanism of natural selection?

A Again, I would prefer to use the demonstration of adaptation as a proxy for showing selection. Evolutionarily biologists and, in particular, those who work on microevolution, have defined adaptation as the result of natural selection, because they see this in their populational studies. We, as Paleontologists, don't contradict this but, rather, what we're seeing is larger scale adaptive changes. Each one of which, when broken down into smaller components, may be as

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comparable to what is in populations demonstrated by natural selection. It's just that, as I explained before, we can't measure the power of selection in fossil populations. This is on a bigger scale. I can give you an example.

Q Do, please.

A We can look at the evolution of the wing in birds as an example of this. The wing involves several things. The bones of the arm and the fingers, the hand, those are changing. Feathers are evolving. They have to form a wing, an airfoil that's capable of supporting the animal in the air. There has, also, to be a flight stroke that is movement of the forelimbs that actually powers the animal forward. This is a very precise motion in order to make this work. And there are also changes in the neuromuscular components, the brain, the physiology, the base on metabolism. All these things are built into how we understand flight-originating birds.

And we now have small dinosaurs that are not birds, but are closely related to them, and they have feathers. They have feathers of different shapes, forms, sizes. And these feathers are not as big as the feathers on bird's wings, nor are the arms yet quite as long as they are in birds, even the first birds. And

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what we see with these, with the evolution of these feathers, is that they're not evolving all at once. They start out small and very simple. Almost as hair like filaments. They're all over the animals body, and they would have been a kind of insulation.

So the first thing we determine is that the original function of the simplest feathers was insulation. They then become branched, and they have a central kind of stock, the same way a feather does today. And the -- these feathers are simple, too, but we find banded color patterns on them. By which we infer that they had a role in display, camouflage, or allowing individuals to recognize members of their own species.

We have fossils of dinosaurs sitting on their nests of eggs, in which position they died, for whatever reasons. They're spreading their fingers over their eggs. These fingers in related dinosaurs have long feathers coming off them, by which we infer that these feathers also serve to protect the eggs when dinosaurs were brooding. So here are three functions of feathers that are simpler than the feathers in a bird's wing that evolved before feathers and such were used for flight.

So we're looking at a sequence of cumulative changes as feathers eventually become larger and more

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complex and finally, air worthy. And eventually, the function of flight evolves, as well.

Q Let me stop you there and ask you a few questions to see if I'm with you. First, when we started out talking about whether paleontology could show the mechanism of natural selection, and I think what you said there is, not directly, but you use adaptation as a proxy for that?

A That's right.

Q By looking at the persistence of a given adaptation, which I think results in the enduring, if I may say that, of transitional features; is that correct? That -- once that becomes adaptive, it's a positive thing. So that's how -- that's the way in which paleontology tries to put its finger on the mechanism of the natural selection?

A (Witness nods head.)

Q That's a yes?

A Yes. That's as close as I think we can get.

Q Okay. Now, here with the feathers -- I was going to ask you about this, because this is absolutely fascinating. What you seem to be saying is, that there are features that are developing, which initially don't have a function, they acquire later on. That's one thing. But as I trace through that process which you

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sketched out here and given a lot of time and thought to, it seems like at every stage in the process, you're inferring a function that allows the -- if we could call -- I don't know what you call, I'm sure you have a word for them -- the precursor to the feather, to develop, it's got a function. And that's, you're sort of weighing the evidence. You should make those inferences. The first you say are hair-like?

A Yes.

Q All right. And you have inferred, you made a reasonable judgement, if I may, that that's probably an insulation function?

A Yes.

Q Okay.

A Because, if I may add. By comparison to similar structures in living animals, hair-like fur in mammals, hair-like feathers in things like Kiwis, very simple feathers, these have an insulator function.

Q Okay. Then the same thing as you go along through the -- as you trace out the process at each stage, you're looking at what you see in the fossil record in light of what you see in other fossils, and then it appears current living animals with a similar feature?

A Yes. And so in birds, we observe that feathers

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have many functions, some of which we can track now in these extinct dinosaurs that weren't birds and didn't fly, but were closely related to them.

Q You know, as I look at your description of the fossil record, what is the -- what does punctuated equilibrium show about natural selection, does it show anything?

A I wouldn't think so. I think it more is an idea that describes the pace of what we call morphological change. That is, change in features of a lineage.

Q Okay. As opposed -- now, when you say change in features of a lineage, is that new species or not?

A The -- it is an idea about speciation that's based on morphological change. So here is a lineage that basically is not changing very much through a long period of time. Then in a relatively short period, it seems to make a change that distinguishes it comparably as a new species. In other words, the new guy is distinct enough from the old guy that it would be characterized as a species by anyone who looked at it with a professional understanding. And if -- and how do we know that these things really are species in the fossil record? We quite often do it by comparing them to related living forms to see if they actually have the

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same kind of and degree of differences. And it turns out that the studies that have been done say, yes, they do. So they are consistent with difference we see in species today.

Q Okay. And you sort of read those back into the fossil record and say, these are more -- this difference between fossils is more kin to the difference we see in these two living examples?

A Yes.

Q Okay. And we know these two living examples are a different species for a variety of reasons. And therefore, we infer that these fossils -- remains must also be.

A Yes. And therefore, for animals that are completely extinct, we use the same kind of degree of difference --

Q Okay.

A -- to establish that.

Q Okay. To establish the classification as a different species?

A Yes.

Q When you -- again, I'm just trying to understand. Does -- is there a theory in paleontology as to how this punctuated equilibrium relates to the mechanism of natural selection? I mean, can it be

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accounted for by the existing theory?
A This is going to get complex. I'm sorry. But when --
Q Is it yes it can?
A It can.
Q Can exist in theory account for punctuated equilibrium?
A Yes.
Q Just give me as brief an explanation as you can, so I can --
A When it was proposed, the idea was that the reason that you're seeing no change for a long time is, basically, that organisms are more or less happy with what they're doing. So they don't change very much. One possible explanation that was proposed is that a population on the fringe of the whole range of the species diverges in form from the others. This can happen quickly in semi-isolated small populations, particularly. Evolution can happen especially fast in -- that was always the prevailing understanding.
And then the idea was that this fringe population could then come back into the main range and sort of swamp or take over, out compete, or for selective, or whatever reasons, take over that parent population's range, and then persist through time after

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that. That supposition or idea is very difficult to test, but it was based on the prevailing understanding from population biology of the 1950s, 1960s and earlier, that established that this could happen in populations today. Therefore, the suggestion was made that maybe this is what's going on in fossil population, but we couldn't directly test it.
Q But that is the way, currently, paleontology deals with this notion of punctuated equilibrium, that's the sort of working hypothesis, if I may?
A It's one idea, Pat, but I don't think it's one that's very strongly explored, because it's just very difficult to get information about that stuff. It's -- questions about punctuated equilibrium relate much more to the pattern that we're describing of not gradual change into the new form but, rather, persistence of a form, and then fairly rapid change and then persistence after that.
Right now, Paleontologists, when they work on this question, are still trying to ask whether this is the prevalent pattern in the fossil record, how common is it, how rare is it. We need a lot more information about that.
Q Okay. So I understand you, is it -- in other words, the very existence of punctuated equilibrium, as

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you see it, is an open question in paleontology at this time?
A No. It's been demonstrated in a great number of cases. The question is, has it been accessed for all possible cases. And the answer is, no. It's still a fraction. We have a quarter of a million species in the fossil record. Some of them, you could ask that question of. Many of them, you could see not. But the number of cases that you could ask that question has not been fully assessed.
Q So again, just so I understand you, is it your view that, in light of these difficulties you've described, some of which it appears arise from the incompleteness of the fossil record versus, in certain areas, it's not yet clear whether punctuated equilibrium is a general characteristic of evolutionarily change?
A It's not clear whether it's more common than gradual change. And if so, how much more common.
Q Okay.
A Does it apply to 99 percent of cases or 40 percent of cases? In either case, whether you have a punctuated pattern or a gradual pattern, selection could still be working.
Q And I guess that's -- that's, you know, again, what I was trying to get you to explain to me, is how

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does punctuated equilibrium fit in with the selection process that we've discussed today? How -- at least how do paleontology see that?
A I don't know that it's been extensively explored.
Q Do Paleontologists -- I'm sorry. Were you done?
A That's all I can say about it. I don't know if it's been extensive.
Q Is there --
A It's a good question.
Q That's a good question.
Is there a working -- you've described this notion of the range, a group on the periphery, you know, and so on, sort of displacing the parent population based on an advantage they received while on the fringe of the range, as you put it, and indicated that, in some measure, that sort of working hypothesis was derived from sort of current observable evolutionarily phenomena. Is there any other hypothesis that's being worked on?
A Let me say first to maybe clarify your earlier question. That the very process of coming in and replacing, out-competing, or whatever, if that model were correct, would be a selective process.

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Q Okay.

A Could we observe the selective process in the fossil record, no. We could observe its effects and infer selection is one possible mode. Would there be a difference between punctuation and gradual change in that regard? No. Because gradual change of a population was also traditionally understood to be the result of selection, little by little on a lineage moving through time. The same kind of selection that people have observed in population cages in the wild and in laboratories for flies, flour beetles, and so forth; and that Darwin wrote about, early in the origin of species when he was talking about domestication of plants and animals, which is known by the term 'artificial selection,' but it has the same effects as his natural selection, when he posits it.

So to come back to your question, does punctuated equilibrium involve selection? By inference, it would, as gradualism would. It just would act in slightly different patterns.

Q Okay. And then in terms, again, if I -- I'm trying to look at this mechanism, the mechanism of natural selection. Again, I just want to make sure. It seems like there's some genetic event that produces a change; is that accurate? And then, there's the

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interplay between that genetic change and the environment, which confers the advantage, and results in selection; is that an accurate --

A I would say that change -- let's see. Change can happen for several reasons. The environment can force it, for want of a better word. Either you do this or you become extinct. Or, it may present an opportunity to which variations that organisms can express might be able to take advantage of. I know that syntax was convoluted.

So it's -- it can work in both ways. We cast evolution as genetic change, and that's true because it's all heritable. We often perhaps underplay the importance of behavior, flexibility in evolution. If the phenotype is not flexible, that is to say, if organisms cannot react to changes, obstacles, and opportunities in their environment, then they won't have as much success as those that can take advantage of change. And so behavior is a big -- and I think, in so far as it regards flexibility, is a big part in here, too.

Those plants we talked about before that find their way up to the mountaintop, we know that sometimes they will be stunted because the conditions are harsh, but if we take some of their seeds and plant them back

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on the flats, they'll grow perfectly fine in the next year. All this is telling us is that the organism is, that is the individual itself, is experiencing insults to its growth by the environment, the same way we would by scars or injuries or damage as we would be growing up. But through time, if there are variations in those populations that -- that naturally make these plants shorter or able to withstand cold more or able to bloom faster, those variations in the population, which incidentally, are mutations, they are simply alternative forms of genes, like we see all through our populations. Then those would be selected upon, and that will become a genetic hardwired thing, so that when you transplant those seeds down to the flats, they will still be stunted, they'll still be short plants like they were up in the hill.

Q Okay. So that's -- and that is what I'm just trying to get a handle on here. It's -- that component is when we would traditionally think of it as a different species; is that correct? When it's -- it's acquired or made its own, these changes that allow it to do well in the new environment on the mountaintop, but not in the old environment?

A Whether they are a new species is a proposition that we could test. We could examine that, and we would

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do it by trying to cross them. If they could not reproduce, then we would say, yes, of course, they're separate species. If they couldn't reproduce, but they were up here in the mountaintop and down here and they really weren't going to practically do that anymore, then we would see them as different species for geographic and ecological reasons.

(Recess.)

BY MR. GILLEN:

Q Kevin, I want to see if I can wrap up this part of these questions. Which, again, I ask you to forgive me. I'm just trying to understand your discipline.

It seems -- is this true that -- we've discussed a number of facets or dimensions that come into play in describing evolutionarily change in species, and it seems like one element of some of our discussion is focused on this genetic facet of it; the role of genes and producing the -- certain changes. And based on what you said, I would -- is it accurate that particular facet of the process, that's not the principal subject matter of paleontology?

A The gene structure, no.

Q Okay. And the mechanism of gene change?

A Correct.

Q And then, we've discussed this mechanism of

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natural selection. And I've been trying to understand how paleontology speaks to that. And I think -- I want to see if I've understood your testimony so far. It's that it -- paleontology identifies the fact of selection by tracking these changes, looking at, I believe you called "the proxy of adaptation"?

A I think that's accurate, yeah.

Q Okay. And then, as I was thinking about your testimony this morning over the break, it occurred to me that that, in a way, the mechanism of the -- the mechanism of the selection, what makes a change advantageous is likewise, sort of a subject of reasonable inference on the part of the Paleontologist. He sees the pattern of adaptation, he infers that there's selection at work, and then, along the lines that you've testified to this morning, you sort of use what you know from various disciplines, current species and the like, to make an inference as to what the precise mechanism of selection was in a given case; is that accurate?

A What the selective forces are, what we might say.

Q Okay.

A Or what the opportunities were that were being taken advantage of. And we look at that, as we

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discussed, by studying functional, elaboration change, "improvement," in quotes.

Q Okay.

A In a lineage through time. And you're right that -- although, we don't directly study the genetics, we are working on what are obviously heritable changes, not simply accommodation to local conditions by any given organism at a time, sure.

Q So now -- then we have this work that you've done on the wing. And I began to read it, and forgive me, but it's fascinating, but I can't follow it all the way through. If I look at that, as an example, I see you as applying the principles we just thought of as looking at the changes, and then because they're enduring, your mind as a Paleontologist, looking for, well, why would that be, what advantage could be presented by this developing feature; is that accurate?

A Well, we look at -- you're correct that when we look at similar features in, for example, feathers and other structures of living birds, we can get a better sense of what those things might have done as the same structures in dinosaurs that weren't flying.

Q Okay.

A So it's not just looking at the structure and making a guess about -- or an inference about things.

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It's rather reasoning based on comparative evidence. So we know what the functions of the feathers of different shapes are in birds today, we can look at those same structures in fossil animals and go, oh, well, that's probably what they were doing there. In the case of these little hair-like feathers even that cover the whole body, we know these are de facto insulation. They would have to be insulator or they couldn't simply exist on the body and not have something to do with warming or cooling. Yeah.

Q Okay.

A Okay.

Q And then, let me just get that so that I understand you. When you say we know they're insulation, because you're saying the fact of their existence, they have to either warm or cool based on what we know about hair?

A Hair and feathers today, that's right.

Q Okay. And then -- but if you see them enduring through time, and therefore, being properly classified as an adaptation, I believe, something that's a positive development; is that accurate, Kevin?

A I think we can call them adaptations if we can show that their structure as a change from a previous structure would confer some function that wasn't there

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before, then we can start talking about new functions, which, presumably, are adaptive. Because if they were maladapted, bad for the organism, presumably, they wouldn't have survived. And if they were of neutral value, why would they be there at all in the first place.

Q All right. And that's exactly what I was trying to get a handle on. There's an inference that if they're enduring, they're conferring an advantage, because otherwise they drop off?

A We do this for some features. We don't pretend that every confirmation of every structure has a function that's incredibly adaptive. Otherwise, we'd lose our minds. But we don't -- for example, the shape of the bridge of the nose, we could make up stories about it being adaptive, but frankly, they don't work. And they -- the bridge of a nose is not there in order to hold your glasses. So we kind of draw that line at some -- at making inferences about everything.

Q And in that line, Kevin, is it drawn -- just along the lines here, your answer suggests sort of a plausibility. Is there a plausible explanation to be advanced for the feature to be understood as advantageous?

A We generally focus on adaptations that we think

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are of some strong ecological or functional importance like wings, ears, flippers, just things that help an organism in the way it performs so much of its daily life. We may not worry about the configurations of more minor features in every respect, you know, the shape of the ear lobes is not something we worry about as an adaptive question.

Q Okay. Now, let me ask you, too, when you're looking at these -- the forces of selection, then, again, is that the subject of reasoned inference on the part of the paleontologist?

A Yes. I would say that evolutionarily biologists of all kinds, those that work on populations or genetics, would accept that when paleontologists study the evolution of an adaptation, like the wing or the flipper or whatever, that this is the result of natural selection, even if we can't directly measure it, but by extrapolation, from what it is observed in populations. And knowing that these species or in these lineages that we're watching change, are simply, when broken down, consisting of smaller lineages like we see today, changing like we see today, then it's all of a continuum.

Q Okay. And when -- I think my question was imprecise. When we look at what is allowing certain

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branches to endure and certain to -- you know, certain to be become extinct, there, as I understand your testimony, we understand that there's this causal connection between the features and the environment and there's some way in which in the features that you're seeing persist through time are conferring an advantage. And as a paleontologist, you're trying to get a line on that advantage.

What I'm just trying to get straight, in my mind, is this idea that when you do that, it consists, in you as a paleontologist, looking at a variety of possible explanations for the advantage that could be conferred by the feature you're focused at a given time, and then entertaining a hypothesis in that way; is that true?

A Yes.

Q And I want to ask. I mean, you have a very interesting comment about your -- one of your mentors, I think, John Ostrum?

A Yes.

Q And I think you called it, at one point, he had a view, which I understand that you do not agree with the way in which it's been portrayed in Pandas?

A Yes.

Q What I'm interested, though, just in the

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process that led your mentor to first advance the notion, as a hypotheses, and then, as you put it in suc' a gentlemanly way, to sort of retrack it, when he thought it wasn't tenable. Because that, I think -- that will help me get a handle on -- let me get a page here.

MR. ROTHSCHILD: Page 13.

MR. GILLEN: Thank you.

BY MR. GILLEN:

Q I'm not interested in the conclusion particularly, or in the -- in any way discrediting your mentor, That's not my point. I just want to see like what, as a way for me to understand the process, the judgements that you're making, you're familiar with this work. What was it that led him to advance that notion that, well, maybe it was a --

A Insect net.

Q Yeah, insect net. You can say that. I don't want to.

A He called it the insect net. It was very funny.

He reasoned that the first birds were small, and that they came from small dinosaurs that were carnivorous. Well, if you're small and carnivorous, what can you eat. You can eat little lizards, you can

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eat baby whatevers, but you can certainly eat insects. And an animal the size of a chicken or pigeon running around in the Jurassic is likely to do what such animals of that size do today, which is eat insects.

And so -- and he knew from its structure that it's a bipedal animal. It's running around on its back legs. Its forelimbs are free from locomotion. It has relatively long arms. The arms are almost as long as the legs. And it's got very long and prehensile fingers capable of grasping. And if you have feathers, even not very long ones, attached to these fingers, and you were running along trying to catch insects, wouldn't it help you to have big flyswatters on your hands.

Now not that there was any direct evidence for such long feathers on the animals, he knew at the time, in fact, there wasn't. Now there is. But his proposal was based on an inference of what he could tell about the probable ecology of the animals that the first birds came from and going from there to a wing with long feathers that could be used in flapping and flying; he proposed that there would be an intermediate stage based on what he would regard as a reasonable guess about its possible function in ecology.

As it turned out, a few other scientists were sitting down over, you know, coffee one day, one was an

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ornithologist, one was a chemist, one was a physicist, and they started to talk about this. And as people do, you know, scratch notes on a napkin, and these guys said, you know, I've been reading this paper -- which he wrote a popular paper in a scientific magazine -- reading this paper, and he said it just doesn't make sense, because if an animal jumped up and grabbed insects like that, it would lose its equilibrium and tumble over. And they showed how that actually was the expected result.

Now, they didn't establish or prove that, but they said this would be a problem. They said, instead, if the animal is running along with its hands out to the sides, if it jumps up to grab the insect with its mouth, the proto wings now here are stabilizing the animal and increasing its lift, and maybe that's good in the process and it wouldn't go tumbling head over heals.

And John, when he saw this paper, which I remember was sent for review, he said -- he said what do you think about this. And I said, I think they got it right. I think it's really a much more important function in getting aerodynamics than in distracting it for another function, which would really take it off the path of improvement toward flight.

And John, who always had his own ideas and was

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a very good reasoner about things, agreed quite readily. And he later wrote in a paper that he published, the insect net hypothesis is dead, it served its purpose. Because he put out a hypothesis that these guys were able to chew on and show the problems with this, but, you know, we've got maybe, if we just adjust it this way, move the prey catching function from the hands to the mouth and use these instead for balance and lift, then we'll get a better result.

Q Now, is that -- I admire, too, the openness to the other hypothesis. I mean, that is beautiful.

Is this an example of what you called functional morphology?

A Yes.

Q Okay. Let me just ask you another question about the Cambrian Explosion and the fossil record. In your report, you take issue with Meyer's effort to explain the pre-Cambrian Explosion. And I notice that there you -- in connection with that observation of yours, I think it's on page 16.

MR. ROTHSCHILD: Just for the record, it's just Cambrian Explosion. That's part of the problem.

MR. GILLEN: Thank you.

BY MR. GILLEN:

Q You say there that the Cambrian Explosion has

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been known for decades to be mainly a problem of fossil preservation?

A Yes.

Q Now, I just want to get a sense of what that means to you as a paleontologist. What is the problem?

A The problem is that we have to read the life of the past from the preserved rocks. The problem is that the longer rocks lay around, the less chance you have of finding what you're looking for. Rocks that are 15 million years old are far more likely to be preserved than rocks that are 500 million years old. Lots of things happen in this interim.

We have no sea floor older than the Jurassic about 200 million years ago. The reason is, that continental plates keep moving up against each other. And as they hit each other, quite often, one of them is drawn down into the earth beneath the other one. That crust then becomes recycled, melted and lost. This has been going on for so long that we have no sea floor, as I said, older than 200 million years ago, which is not very -- it's only a part of the fossil record.

The Cambrian forms we're talking about lived on the ocean floor. So the only place now that we're going to get records of ocean floor older than this is if that ancient ocean was somehow thrust up on the continental

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surfaces and preserved, not eroded, but exposed to the surface now so that we can uncover it and find things. You can imagine that the chances of getting a complete record of something as far back as the Cambrian and immediate pre-Cambrian, are very small. We have pieces here and there. Like a book in which you're pulling a bunch of pages out from one chapter, and then skipping 20 pages and pulling -- you know all the metaphors. It's the same idea.

Q But it is interesting and you are helping me understand.

Is it that, therefore, there's various strata in the Cambrian and you -- what's lacking is a piece, so to speak, that allows you to get through the strata that are associated with that period?

A Let's say that there are increasingly more gaps in the record, all things considered, the farther back we go. It's as if you had a stack of paper, and from the -- moving from the top, you pulled every other page out, and then as you got farther down, it was every third page, and then every fourth page. By the time you got to the bottom, you'd be taking every twentieth page, and you wouldn't have a very good sense of the continuity of the -- you might -- on those pages, there would be lots of available information. You could,

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depending on what sort of document you were looking at, connect those pages even though they might be 20 pages apart. Does that help?

Q I think so. Are you saying them, Kevin, that the problem of the Cambrian Explosion is that it may appear more explosive than it was simply because we're missing the intermediate strata or pages that would allow you to see a more gradual transition of the kind you see in other periods?

A That's a part of it. Yes. That's a big part. And the other part of it is, that there is -- the other part is the question of how to read the pages that are preserved. So in the early Cambrian, the so-called Explosion, is occurring in a five, ten million-year period, which is a lot of time. It's not an instant. And a lot of the major groups of sea animals that we know today are found by the end of that Cambrian Explosion. They don't all appear at once.

And there are also indications of those animals before that five to ten million year bracket. In faunas of very small-shelved animals from five million years before that, for example, we have mollusks of various kinds. We have brachiopods. We have other calcite tubes that suggest various kinds of worms or other animals. And some things we just can't really tell that

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they have any further relatives.

If we go back 20 million years before that, we have the burrows of animals that are progressing along the ocean floor. They're kind of trackways, if you want. And these are just linear wormy type things going along. But we know that those animals must have had a head and they must have had legs or some kind of locomotory ability to go forward.

Therefore, they have features of the organisms that we find at the Cambrian Explosion. We call those animals metazoans, which are generally multi-celled animals.

If we go back 70 million years before this Cambrian Explosion, we have the remains of embryos. Amazing to find them, but you never know what's going to be preserved. These embryos have complex features that are associated with metazoans. So we know that at least some early members of the metazoans must already have existed 70 million years before the Cambrian Explosion.

These facts were ignored in the treatment of the Cambrian Explosion by the Intelligent Design proponents. Was what they said true as far as it went? In part, it probably was. Is this the way to explain a problem like that to schoolchildren? No.

Q When you say that, Kevin, let me just

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understand you. You've given us now an increasingly longer period of time prior to the pre-Cambrian.

A Cambrian.

Q Sorry, Cambrian.

And the -- in which, if I understand you correctly, you're saying these are precursors to some -- or, arguably precursors, to some forms that we see in the Cambrian period; is that accurate?

A We conclude that they are members of the metazoans, if very primitive ones. We do not necessarily say that they are the embryos or the tracks of lobsters or clams or anything like that. We simply know them as metazoans in the same way that we have horses and elephants and impala today. But if we went back 50 million years to their ancestors, and looked around North America and Africa, we wouldn't recognize anything like a horse or a springbok or an elephant that we see today. We would see much more archaic-looking animals.

Q And then you made a statement to the effect that the presentation of this subject matter was deficient in your judgment. Tell me why, just explain, what is it, you said it's true as far as it went, but you thought it was not the way to explain it to schoolchildren.

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A I think without including evidence of the small shelly faunas of the bilateral trace fossils, and of the ancient embryos, you are pretending that all this change is happening in a much briefer window than it actually appeared in. And I don't know why someone would want to do that.

Q So you -- in other words, it -- how should we say -- it exaggerates, in your judgement, the sense of explosion by failing to trace back to these precursor forms?

A By leaving out all of the important information that could relate to a more distant genealogy.

Q Okay. And that's what I'm trying to get at. You say this earlier information that could relate to a more distant -- did you say genealogy?

A I did.

Q Okay. Is it -- is the view that you described, is that an accepted view in paleontology?

A Yes.

Q And so, therefore, is it -- I just, again, want to make sure your objection is that it seems this treatment in Pandas is -- has an artificial temporal boundary imposed on this examination of connections?

A Yes.

Q Okay. On page 15, Kevin, you are speaking, at

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the top of that sentence beginning at the top, to the fossil record, and the way in it's inductive. And you say there, "We" -- I believe you're referring to your profession community of paleontologists -- "derive general inferences based on countless examples, which present us with repeatedly tested and confirmed patterns from which the history of life is reconstructed."

And then you go on further. I just want to understand, is that -- is that statement there, a reference to what we've discussed this morning.

A Every time we go in the field and find a new specimen, it provides another -- we would say datum, singular of data -- point. Another piece of information that tests our ideas about what we think we know of the -- of the pattern of life through time. If I was working in Cambrian strata and let's say I found a horse tooth, that would be a little unusual. We don't know if horses anywhere back that far. And immediately, of course, we would want to see whether this was a correct identification, whether it was something that washed in from another place, whether -- any other possibilities. But we don't find those things.

When we go out, we find the usual trilobites and ancient snails and other sea creatures that lived then on the ocean floor. They don't really jar our

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understanding. And that's what I mean by being confirmed by countless examples. Every time we go out to do this, we're actually testing our whole theory of the fossil record.

Q Now, I do have a better understanding at what you're getting at.

So in other words, you're -- there's a consistent yield from a consistent period or -- how would you describe it? There's a consistent yield of similar fossils from a rock sample that's associated with that period. Is that what you're getting at?

A We keep getting the same signals, that's right.

Q Now, just to go -- you go on there. These patterns -- and that's what we're talking about -- and the processes inferred to produce them. Now, when you say that, Kevin, what are you getting at there? The process inferred to produce them?

A The processes of evolutionarily change we've talked about.

Q All right. "Are in turn based on conventional scientific methods."

What are you getting at there?

A That when our methods can range from anything from the rigors of typical and correct field collecting to the rigors of correct identification of specimens,

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their classification. The correct identification of the type and age of the rock we're looking at, the reconstruction of their environment, such things like that.

Q Okay. So now, are those methods that you've described, are they dating methods or are they dating and morphology comparisons, how would you --

A They are dating -- they're situating in time and space. And relating those to other data we have of organisms we have in time and space.

Q The dating or situating in time and space, as you described it, what exactly is that? Is that comparing this find against what we know what the discipline holds today about geologic time and geologic, I guess, strata?

A Yes. Which, in turn, is based not only on geology, but on the principus of physics and chemistry, and so forth, which allow us to put what we call absolute dates on ancient rocks.

Q Okay.

A Paleontologists and geologists, just in the field, can look at different rock outcrops and say this one is higher or lower than the other. That's basically the way the whole geologic rock column is established, but no one new exactly how old these rocks were. That

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depended on isotopic dating that was based on the understanding of radioisotopes that came directly from physics and chemistry, having nothing to do with paleontology, biology or evolution.

Q And then, you've also indicated that another element of this -- of the method, the method of paleontology is the morphology -- the classification?

A Yes.

Q Is that what we discussed earlier today?

A With that funny word, synapomorphies, everything associated with it. How we classify organisms in the tree of life, yeah.

MR. GILLEN: Let me ask Ana to mark this as Exhibit 2.

(Defendant's Exhibit 2 was marked for identification.)

BY MR. GILLEN:

Q I know, Kevin, I just want to get some additional detail on your notion that -- whether you have an opinion concerning whether Intelligent Design Theory or Intelligent Design Creationism, as you call it, is a science properly -- considered as a science. Do you have an opinion on that?

A My understanding of Intelligent Design is that it does not qualify as science.

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Q It does not qualify as science?
A Right.
Q Okay. Now, if -- I want to ask, if you look at page 15, and you have a conclusion there that the order of appearance of the major groups of plants and animals records with the expectations and patterns of the evidence and theory of contemporary evolutionarily biology. Is that what we've discussed today, the way in which the findings of paleontology support evolutionarily and biology, as you understand it?
A Yes.
Q Okay. Now, you have an opinion that Intelligent Design is not science; correct?
A Yes.
Q Just tell me why.
A I guess it would be more appropriate to ask why it is science. It makes no predictions that have been tested empirically. It has not shown that existing understanding is so insufficient as to warrant a completely different and supernatural explanation of patterns and processes of life. It has not ever been presented as science to the scientific community, which means that it has no standing as science in the scientific community. And it's difficult to see what would make its proponents give up its major

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stipulations.
For example, if someone were to claim that a particular structure was so complex that it couldn't possibly have evolved through intermediate steps, but must have been created by a designer of some intelligence and presumably, supernatural features, if we then found features that -- in fossil animals, for example, that were, for all intents and purposes, to a reasonable qualified investigator, intermediate in structure, and could explain the transition of form and function, would that then falsify the claim that there was a designer. If it would, then I think we're getting out of the realm of science. And if it wouldn't, then the proposition would essentially be unfalsifying it and it still wouldn't be science.
Q So let me before we -- I try to understand that. Let me just make sure I got the reservations you have down. Seems like, no predictions that can be test empirically, you mentioned?
A No predictions that have been tested empirically, as far as I know.
Q Okay. It hasn't, as a theory, managed to produce a sufficiently powerful criticism of other theories to warrant displacing existing theories?
A But criticism of one theory is not support for

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another.
Q Right, and I do understand that.
Am I understanding you, that's part of what gives you the sense that -- in other words, I see what you're saying. Even if they could mount a criticism of evolutionarily biology, that wouldn't necessarily make the case for Intelligent Design. Is that your point there?
A And I wonder if a criticism of evolution in biology is even necessary to posit Intelligent Design. Why can't there be a designer who works entirely according to natural processes, with no miraculous interventions? Why does this have to depend on criticism of evolutionarily theory, as we understand it?
Q Is that your understanding of the position held by Intelligent Design proponents?
A Insofar as Intelligent Design holds, in general, that -- that certain structures or certain phenomena in evolution could not have evolved, but must have been especially created by a designer. And insofar as the mechanisms that are posed to enable us to recognize this, includes such things as irreducible complexity and specified complexity, yes.
Q Okay. Now, is it your understanding that these concepts you've referenced, Irreducible Complexity and

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then Specified Complexity, are not falsifiable?
A Insofar as they recur to a causal mechanism of an Intelligent Designer, yes.
Q And just why do you say that?
A Because if structures are Irreducible Complexity, they cannot have evolved and must have been specially created. That creation must be by the intervention of some kind of -- of Supernatural Power, because it is not being discussed in natural terms.
Q When -- now earlier, you were mentioning that you didn't see why criticism of evolutionarily biology had to be sort of a feature of Intelligent Design Theory. And I believe you noted that there's a possibility there could be a designer operating in natural ways; is that correct?
A Sure.
Q Now, is that -- that thesis, if you call it that, do you have an understanding concerning whether that is consistent with Intelligent Design Theory?
A My understanding is that IDC goes farther in stipulating that no natural processes cannot account for this and, therefore, we must look for science of a Creative Intelligence that is beyond the natural processes we know.
MR. GILLEN: IDC is short for Intelligent

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Design Creationism, the term used in Kevin's expert report to refer to what I have described as Intelligent Design Theory, just for the record.

BY MR. GILLEN:

Would you have a different opinion about Intelligent Design Theory, Kevin, if the notion of change occurring through natural processes was a part of Intelligent Design Theory?

MR. ROTHSCHILD: Objection, different opinion.

BY MR. GILLEN:

Q As to whether or not it was science?

A We would determine whether that part of it, the Intelligent Design part, was science by virtue of whether it had any consequences that could be empirically assessed. That is, with reference to phenomena in the natural world.

Q Okay. I'm having a hard time understanding what you're getting at there. Can you?

A Science is based on empirical evidence of the natural world. If someone wants to claim the existence of any sort of forces that are not natural, they may do so, but science has no regard. It's not in science's purview to talk about those things. If that's fair enough to say.

If -- for example, let's say most people or a

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great number of people accept the existence of God, accept that God set up the universe, accept that God, or whatever superior being or beings or entity, or however you wish to describe or talk about it, put in motion natural processes that resulted in everything we see around us, and I think that's the mainstream view in religion, would not have to tamper all the time with these things, miraculously, to put flagella on bacteria, wings on birds, and flippers on whales; you might say that it would be very hard to recognize the effects of the Supernatural Being like that. And we would all agree.

So on the other hand, it doesn't stop us from examining the appearance and the processes that are in the world around us.

Q That's what I'm trying to understand, Kevin. It is the notion of, shall we say, intermittent intervention, which you've referenced a few times here? Is that -- I take it, that's a notion that you've associated with Intelligent Design Theory?

A Yes.

Q And is it that which is the basis why you're saying it's not science, because rather than look at natural processes, as you described them, it's sort of just positing, as you understand it, at intermittent

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intervention by some supernatural cause?

A Yes. In that sense, ID becomes a science. What we call a science stopper. There is no reason to investigate this further because we have determined this is too complex to evolve. And therefore, some Creative Intelligence must be at work.

What worries me is, when they find out in any number of cases after having said that, that they're wrong, what happens to the theory? And even if you have a theory, do you have any cases where you can absolutely say this could not have evolved in any natural way.

Q Well, let me ask you, if this notion of intermittent intervention, in what you describe or perceive as a natural processes, were not a necessary ingredient in Intelligent Design Theory, would it then qualify as science, in your judgement?

A It would -- if you remove notions of Irreducible Complexity and Specified Complexity, which are -- I think, it's fair to say are the only two postulated potential hallmarks by which Intelligent Design could be justified, then you have left only the supernatural belief.

Q So let me understand you. Are you saying that those two concepts, Irreducible Complexity and Specified Complexity, are necessarily connected with the notion of

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intermediate intervention by supernatural forces?

A I believe they have been associated with it by people like Dembski and Behe. Because it isn't their writings that we find the corpus of the approach to the empirical world that is not simply the Intelligent Design theology part that would go back to William Paley in the late 1700s.

Q So is it your opinion that Intelligent Design cannot qualify as science because it is positing this intermittent intervention by a non-natural process, as you understand it, is that the --

A It does not qualify because it hasn't shown this in any substantive respect.

Q When you say, "it hasn't shown this," you mean what?

A I mean that no one has provided any evidence for a case where something couldn't have evolved and must have been produced, therefore, by some divine or Creative Intelligence that is not using natural means that we understand.

Q Okay. Let me make just sure I understand. So you're saying that so far none of the proponents of Irreducible Complexity or Specified Complexity had actually produced a case, which in your judgment, cannot be accounted for by purely natural processes. And,

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therefore, you do not see the concepts of Irreducible Complexity or Specified Complexity as capable or as yet, demonstrated empirically?

A Yes. For example, what is written in Pandas about the problems of intermediate changes between birds and whatever reptiles they descended from, even when they wrote this, there was far better evidence then they had to show how those transitions could have taken place.

Now, in the last ten years with the evidence of the feathered dinosaurs from China, we've learned so much more about those transitions, that it's generally accepted. Not simply by the scientists that work on that, but by reporters, by textbook writers, by -- this is the consensus conclusion that's understood in the world of science.

Now, these guys who wrote Pandas 15 years ago ought to be going, whoa, we blew that one. Which is what scientists say to each other all time, because we -- this is -- but it's a case of where nothing has been shown and accepted by the scientific community to require an explanation of Intelligent Design. And so the question is, if this has not qualified as science, why are we teaching it as science, why are we giving it pride and place in science curriculum. I would think

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that you would want to have notions that are really thoroughly tested, accepted by scientific consensus and then put into curriculum textbooks, which is the way we do all the rest of the things we've talked with.

Q So -- all right. I want to understand.

You say it doesn't qualify as science and you pointed to, I think, the fact that, so far as you can tell, there's been no case made for an organism or structure that is irreducibly complex; right?

A Correct.

Q Second, you've said here that it hasn't been presented to the scientific community and accepted as science?

A Correct.

Q Is that, in your judgement, sort of another hallmark of science, or what it takes to qualify as science?

A Yes.

Q You said that it's -- Intelligent Design is a "science stopper"?

A Yes.

Q What do you mean by that?

A Once someone says that, well, God did it this way or the equivalent, and there's nothing else we can investigate about it, that seems to hold all further

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scientific investigation.

Q Do you have any understanding concerning whether people who, you know, endorse, in some measure, Intelligent Science Theory, are engaged in science?

A Some of them may be engaged in some types of science. I am not yet persuaded that any of that really bears on Intelligent Designs, because if it did, we would expect to see scientific publications in peer review journals that essentially test hypotheses about Intelligent Design in particular cases.

Q To your knowledge, I take it, there are none?

A To my knowledge, there are none.

Q You've mentioned this notion of testable several times. I want to get a better sense what you mean by that, "testable." How -- I mean, in what sense is Intelligent Design not testable?

A If you have an idea that something was whatever intelligently design means, and its proponents are not particularly specific on that point when they're discoursing in venues related to science or education, when you hypothesize something as being intelligently designed, what would be the test of figuring that out. So far, we don't have any tests. How would we know that a structure was intelligently designed?

Q Well, that's what I'm trying to get. How you

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approach this. If we look at -- there's two concepts here, I know, that you take issue with, Irreducible Complexity and Specified Complexity. Now, it's my understanding that those are efforts to test the concept of Intelligent Design.

A They are suggestions, but to qualify as scientific tests, they need to be presented to the scientific community as peer review propositions so that the scientific community could say, hum, yes, well, we agree that if we found such structures or such conditions, we would agree with this; however, that has not been done. Neither proposition has been subjected for scientific peer review. In fact, as I understand, that both -- both ideas have been rejected by the proponents Behe and Dembski for submission for scientific peer review, they're not interested in this.

Q Let me just understand. In other words, now, it seems like you're saying, well, Intelligent -- let's say, Irreducible Complexity or Specified Complexity have been proposed as tests, but they haven't gone to the next level, which is accepted as tests by the scientific community?

MR. ROTHSCHILD: Objection, mischaracterizes his testimony.

BY MR. GILLEN:

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Q I'm just trying to understand.
A I can put it in my own words.
Q Oh, yes, certainly.
A So they -- Behe and Dembski may have written about this in popular books and vehicles.
Q Right.
A That doesn't qualify as the business of science. If they want to be taken seriously, they have to do what everybody else does. And what Behe, at least as a biochemist does, in his own more quotidian, for want of a better word, biochemical work, like microquotidian paleontological work, going out and describing a new species of anything from a rock is what we do every day. It's reconstructing the phone book of life.

And, you know, someone like Behe, in his ordinary biochemical work, would submit that for peer review. Here you have an idea that he thinks is the most colossal idea of his scientific career. Why is it that he hasn't submitted this to peer review? Why aren't we reading about this from him in the pages of the most renown scientific journals? Why aren't the Noble people beating the path to his door, and other people, to award him prizes for this, for re-revolutionizing our understanding of a huge central

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scientific concept? Why are they not even trying?
Q Okay. So let me just look back. I'm looking at this -- why you have this opinion that Intelligent Design theory is not a scientific theory. And we're talking about the testability, and then this other aspect of scientific, including the sort of communal element of it, the peer review process. I -- so in terms of the testability, as I say, it's my understanding that Behe, through the concept of Irreducible Complexity, and Dembski, through the concept of Specified Complexity, are attempting to create criteria that would test the idea of Intelligent Design against which that idea can be tested. Do you agree with that?
A I agree that they are talking about this to sympathetic audiences.
Q Okay.
A I do not agree that they are proposing it as science.
Q Okay. Now, in terms of looking at the testing function, do you agree that they have at least presented these as tests of their theory?
A No. I agree that they have talked about them in nonprofessional venues. And I'm not sure that -- forgive me, I would dignify it by calling it proposed.

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I could -- to reduce it to the absurd, I could say, look, I can flip this coin and if it comes up heads, then this proposition should be accepted. Now, of course, that's stupid and no one would ever do that, but I do not see people falling all over each other to look at what Behe and Dembski have proposed and saying, even in an informal recognition sense, hey, these are really good ideas. In fact, the informal criticism, their informal ideas, has been legion. I'm not seeing anyone in these communities, as a whole, pick this up and say, hey, we got to hear more from these guys. Why wouldn't that be happening if this was a good idea?
Q And I do understand what you're getting at. I'm just trying to look at these two features and get a fix on your understanding for Intelligent Design Theory. Your last response, I take your point, which, as I understand it, is that, well, present maybe, it may be presented, but not presented to the relevant -- the people it should be presented to?
A In a certain way.
Q Okay. So I want to make sure I understand you. They have offered Irreducible Complexity as a test of Intelligent Design Theory. That, at least, is something you agree with? Yes or no?
MR. ROTHSCHILD: Objection. I'm not sure

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what -- you used hand quote marks. I'm not sure what that was supposed to convey, but it won't be on the record.
THE WITNESS: Could you say that again?
BY MR. GILLEN:
Q Sure, no problem. Kevin, I want to get to the nub of this. You've got a basis for an opinion that it's not science. I understand that. I'm just trying to figure out where there's a disconnect here. And one of the things that I understand is that there are proponents of Intelligent Design Theory, and they, at least I'm told, are trying to create the test of Intelligent Design by pointing to criteria, which would identify Intelligent Design. It's my understanding that that's why Behe advances the notion of Irreducible Complexity to make his thesis testable.
MR. ROTHSCHILD: Objection, again. You used the word "test" in hand motions of quote marks, and I don't know what that's meant to convey, but it's not on the written record unless I say something.
BY MR. GILLEN:
Q Do you share that understanding, Kevin?
A No, I don't. I think that it doesn't qualify for science for two reasons. First of all, the posits of supernatural agents, which are beyond the reach of

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science. And second, because although they may have talked about these things and published them informally, they have not subjected their proposed tests to scientific peer review. So it is not science, even in it's potential -- potentially testable features.

Q Okay. Maybe I'm understanding you better. That it's -- in order to qualify as science, in your opinion, it not only has to have a criteria by which it can be tested, but that criteria has to be accepted through peer review process?

A And the criteria have to be accepted through the peer review process. Also, and another important component, to the extent that this idea involves supernatural agents, it is no longer the purview of science.

Q And I think I understand you there, but I want to make sure that I do. When you say "supernatural agents," what are you referring to there, exactly?

A Causes, mechanisms, processes and influences, that are not part of the normal behavior of the natural world as we know it. Things that suspend or override those processes or disrupt them or otherwise influence them in extraordinary ways.

Q Outside of the ordinary laws of nature, as we know them?

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A Yes.

Q Okay. Is it your opinion that Irreducible Complexity is not a valid scientific concept?

MR. ROTHSCHILD: Objection to the form. Do we have a working understanding of Irreducible Complexity for purposes of this question?

MR. GILLEN: It's in his report.

THE WITNESS: If you take a structure that performs a complex function, and remove some of its parts and it no longer works, then you can say, well, it's Irreducible Complexity. That's not the same as saying that it couldn't possibly have evolved. And yet, Irreducible Complexity says that it could not have evolved. That is Behe's notion of Irreducible Complexity. He states explicitly that this could not have evolved by natural processes that biologists recognize.

Q In your opinion, I take it, Kevin, that he is -- that is not the case, that is not true what he posits?

A I think he's going beyond the pale.

Q Okay. And exactly in what way?

A Because we do not know, or cannot imagine, a natural way to get from point A to point B, does that mean, therefore, that we will not discover it, cannot

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discover it, or that it could not have happened. Behe is saying yes to all three. Scientists would say we can't say that.

Q So is it -- is it your understanding that Behe's concept of Irreducible Complexity is not scientific because it necessarily entails positing the unintelligibility of a mechanism of creation or change?

MR. ROTHSCHILD: Objection.

THE WITNESS: It's positing the impossibility of a change by natural means alone.

BY MR. GILLEN:

Q And by that, Kevin, do you mean that he has not proven anything is irreducibly complex?

A He certainly has not proven or shown that anything is irreducibly complex, that's true.

Q Okay. But is that why you're saying here that it's not a scientific concept because it's -- he's failed in his proof or because the idea is flawed, which is it? I'm having a hard time following you.

MR. ROTHSCHILD: Objection.

THE WITNESS: It's because when you stop inquiry by saying that it is no longer possible to search for natural means to explain A to B, you are effectively removing the inquiry from the domain of science. And I'm not sure you can be that peremptory

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about the cases that have been exemplified or that would be presented to students in school through things like Pandas.

Q That's what I'm trying to get at. Is it that you think there is the concept of Irreducible Complexity hasn't been demonstrated scientifically so that it cannot be presented as a scientific concept?

A That's part of it, yes.

MR. ROTHSCHILD: Can I have a standing objection? Because you've asked a lot of questions where you take a current proposition that is the subject of discussion and characterize it as the reason. And I think Kevin has repeatedly said multiple reasons, as he just pointed out. I just want to make sure that the record reflects that when you're focusing on a singular reason, that it doesn't -- is not treated as a contradiction of his earlier explanation that there are multiple reasons why these concepts are not scientific.

MR. GILLEN: That's fine.

BY MR. GILLEN:

Q Forgive me if I'm struggling with this, but I'm trying to understand, Kevin, why, you know, you have this judgement that it's not a scientific proposal here that's being offered. And I'm having a hard time getting a fix on exactly what is getting it off in your

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mind as not -- an effort to do science?
A First of all, nothing has been shown.
Q Okay.
A Nothing has been subjected to peer review. And the idea entails supernatural agents that cannot be examined by recourse to natural means. For those three reasons, it's not science.
Q Do you have the same three objections to Specified Complexity?
A Yes.
Q Any additional objections to Specified Complexity?
A Can't think of any at the moment, but those are strong enough.
Q I understand. Are there -- do you have any opinion concerning the specific deficiencies in the concept of Irreducible Complexity as a test for Intelligent Design?
A Yes. One of the things that Behe appears repeatedly to reject is a very well accepted evolutionarily understanding that the form and function of one organism can change into a different form and a different function of the same structure in another organism. We call that -- another funny word -- exaptation, e-x-a-p-t-a-t-i-o-n. And exaptation is when

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a structure that is being used for one function becomes co-opted for a second function. Usually, even while it's performing -- continuing to perform the first function. And through time, this second function takes on more importance. Maybe the first function is never entirely lost, but now the second function becomes much more important. And therefore, the whole thing has changed.

And Behe, in his description of such processes, seems to take this second new form and function and say that you cannot take parts away from it without having it fail its function and that, therefore, it could not have evolved. But he repeatedly overlooks the possibility in the vast literature from the paleontological record, for example, showing that we do see transitions in form and function to very complex things that we don't think evolved out of nothing, but rather, switched their form and function through lineages. We have a number of examples of these things.

And it's -- it's frustrating to many biologists, as you'll learn from Ken Miller and other people, that these criticisms incredibly basic and fatal criticisms of his idea, have not been addressed by him.
Q Is the process that you've outlined for the precursor to the feather, is that an example of ex --

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A Exaptation.
Q -- exaptation?
A Yes. The simplest form of the feather, even in its hair-like filamentous form, shows us that it had to be important in insulation. Well, feathers are still important in insulation. But they also enable birds to fly.
Q So is it your opinion, Kevin, that Irreducible Complexity is not tenable as a test of Intelligent Design because of the possibility of exaptation?
MR. ROTHSCHILD: Objection.
THE WITNESS: I'm only saying that Behe has not -- has not taken into account the ubiquity of exaptation in explaining complex structures and functions.
Q And that ubiquity, did you mention it as an evidence in paleontology, is it evidence in the fossil record?
A Yes.
Q Is there a biological or microbiological account for processes of exaptation?
A In fact, if you want to talk about feathers, it turns out that the development of the feather, that is how it develops from a single little placket on the skin into a plume with vanes and barbs and barbules, and all

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these wonderful structures, that this is essentially mirrored in the development of the feather; that is to say, the evolution of feathers as we see them in the fossil record is, to a great extent, mirrored by the development of the feather on a bird today. And these feathers -- what makes these feathers form and how they open up and formal on their axis and bifurcate, and do all these things, the genes that control this now are very largely known.

I believe I referred to a paper or several papers in my report by Rick Prum, Prum and Williamson, Prum and Brush, and some of their colleagues, in which then explained these things quite nicely. And there's an example where the genes really do tell us how these structures came to be the way they are, what genes actually control this.
Q How about Specified Complexity? Does -- I mean, it seems to me that that -- does that effort to create a test for Intelligent Design, does that fall because of exaptation?
A No. It fails because it uses a completely inappropriate model of evolution as we understand it.
Q And is that the probability calculus that you reference in your expert report?
A Yes.

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Q And you see that as a fatal, sort of methodological flaw in positing the evolutionarily probabilities?

A Because it doesn't describe the process of evolution as we know it.

Q When you say that, are you referencing the portion of your report that talks to the way in which the certain changes are maintained in the genes?

A Yes.

Q Such that the probabilities are -- it's not starting over each time?

A Correct.

MR. ROTHSCHILD: Does anybody need a break here?

(Recess.)

BY MR. GILLEN:

Q Kevin, I've marked something here -- what is it, it's two; isn't it?

A Two.

Q All right. And I'd ask you, if you would, to look at couple of indented --

A Yes.

Q -- paragraphs there.

And particularly, the indented paragraphs that begin at the bottom of the first page and carry over,

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four indented paragraphs.

A The first paragraph is pretty funny. Just because it's says it identifies Intelligent Design as another theory of evolution. That's complete nonsense. That simply doesn't compute. It wouldn't be identifiable as that to any scientist. It has absolutely no track record. It's not on the table as something scientific, let alone a theory, which is the strongest construct in science.

MR. ROTHSCHILD: Kevin, can you just be clear about which paragraph you're talking about?

THE WITNESS: This is the one about the biology curriculum, and it's also been updated. And the paragraph begins, "Students will be made aware of gaps/problems in Darwin's theory," et cetera.

BY MR. GILLEN:

Q Okay. So -- and there, Kevin, if I understand you, you're basically saying Intelligent Design Theory, as you know it, is not a theory of evolution?

A It's not a theory at all. It's not a scientific theory at all. And it's certainly not -- doesn't have any standing as a -- as any concept in evolution. It's a concept of antievolution.

Q And then when you say, "It's not a scientific theory at all," what do you mean by that?

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A By theory -- and if we can, I think --

Q It's there, I believe.

A Yes. "A theory is defined as a well-tested explanation that unifies a broad range of observations."

Q Okay. Do you accept that definition of theory as a plausible working definition of the term?

A It's a good general definition of a theory in science.

Q Okay. And you've expressed an opinion that Intelligent Design Theory is not a theory at all?

A Right.

Q Explain why you have that opinion, Kevin.

A First of all, it's not tested. Second of all, it doesn't explain anything. And third, it does not unify a broad range of observations.

MR. ROTHSCHILD: Just for the record, the definition that's being referred to is actually in the document, Exhibit 2, and is on the bottom paragraph of page 1 of that document, part of the statement read to students.

BY MR. GILLEN:

Q All right. If you look at those four paragraphs that start at the bottom of the first page of Exhibit 2 and carry over.

I'm going to represent to you, for the purposes

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of the deposition, that this is the statement you referenced earlier that's read to the students.

A Yes.

Q Now, my -- in your report, there's a number of places where you refer to Intelligent Design being taught or Intelligent Design being presented. And I can tell you that this is the sum total of the presentation to students in the classroom. What I'm trying to get at here is, does this -- knowing that, knowing that this is the sum total of the impact on classroom instruction, that follows from the curriculum change, do you have the same opinion concerning the decision made by the Dover Area School District to present Intelligent Design Theory to the students?

MR. ROTHSCHILD: Object to the form of the question. I think it mischaracterized the evidence by saying it's the only impact. I will agree that, to date, this is -- the statement is the only words said to the students in the classroom.

BY MR. GILLEN:

Q Okay.

A With that understanding, I believe, also antecedent to this statement, there was a statement in the curriculum.

Q That's true, but the students don't see that.

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A It doesn't matter.

MR. ROTHSCHILD: Object to that characterization.

THE WITNESS: It doesn't matter, I think, if the students see it or not. It matters that it's there and it has an effect on teaching, because the teachers are supposed to see it. And therefore, it will determine what and how they present biological topics in the classroom. So it -- I think it does have an effect on instruction.

BY MR. GILLEN:

Q Tell me what you think -- what effect do you thick it has?

A Do you have a copy of the statement handy?

Q That's it.

A In the curriculum?

Q No. Oh, that's right there.

A I'm Sorry. That's the one?

Q Yes.

A "Students will be made aware of gaps/problems in Darwin's theory."

First of all, this is assuming that there are gaps and problems with Darwin's theory, and that these were not already emphasized and/or that they should be emphasized, and that they should be emphasized more than

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any gaps in any other theory in science. For example, gravitation, cosmology, relativity, whatever theories are being present. Why is evolution being roped off here and considered separately?

Second, this curriculum statement represents that Intelligent Design is a theory, a scientific theory, which it is not, and that is the theory of evolution, which is it not. It is a theory that denies evolution and posits divine intervention.

So, I think, to begin with, Pat, that's something that it may be transparent or not seen specifically by students, but it definitely will have an effect on how biology is taught if teachers follow these instructions.

Q Well, let me ask you about that, Kevin. What is the impact that you see on the classroom instruction?

A One thing, which we discussed before, is that it makes the presumption that Intelligent Design is somehow incompatible with evolutionarily theory, which I think is a religious notion. And it probably isn't even a correct religious notion for most Americans. I'm not really sure that you can admit it here as a statement about science in the first place.

Q But, I mean, I'm trying to get focused on the classroom instruction, because you've -- you know,

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you've --

A Okay.

Q -- we're -- we're concerned with the presentation of biology and evolutionarily theory in the classroom. And you have a sense that this statement in the curriculum is going to influence that presentation of biology, which is the actual subject matter that's taught in the classroom. And I'm trying to figure out how.

A If you presume that teachers are expected to follow the curriculum, then it follows that what is in the curriculum will be what should be taught and, therefore, is taught in classrooms.

Q And when you say, "should be taught" and "is taught," are you referring to Intelligent Design?

A I'm talking about anything that's in the curriculum. A good teacher's job is to follow what's in the curriculum. Teachers know that if they don't follow what's in the curriculum, they can be reprimanded or even dismissed. So if this is officially in the curriculum, then it must be considered important and it should be followed by the teachers, therefore, it will be pursued in classroom instruction.

Q Do you know whether the teachers have been told not to teach Intelligent Design?

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A If they have been taught to teach Intelligent Design, then that countermands what this says in the statement in the curriculum, because it says that students will be made aware of Intelligent Design.

Q Okay. Well, let's look at that. I mean, I'm -- let's -- you focus on the curriculum statement, let's look at that. "Students will be made aware of gaps/problems in Darwin's theory."

Do you have any understanding concerning whether there are any gaps or problems in Darwin's theory; is there?

A There are problems with every theory, but it's all in how you conceive what Darwin said. There are many ways to develop, elaborate, and test what Darwin said, but Darwin is not the only person who has contributed to evolutionarily theory. It's been close on 150 years since the origin of species. A lot has happened since then.

Q Sure.

A So if you take that entire corpus and say, are there any things that we don't know yet. Well, of course, there are. We could say the same thing about gravitation. Is there a fifth force? That keeps coming up. About relativity. I don't even know what -- a lot of extreme theory and things in physics are, but I know

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there's lots of problems with every major scientific theory we have. Otherwise, we wouldn't have the need to do it anymore, we could all good home.

So these are -- as far as gaps and problems, yeah, there are gaps and problems. We see these things, good things, for inquiry. As opposed to the connotation here, which is clearly, it seems to me, one of deficiencies or inadequacies or incorrectnesses.

Q Okay. It's based on that sense that you have, that you find this problematic?

A In part.

Q What else?

A Well, in -- as I've said before, it's -- it's treating Intelligent Design as a theory of evolution. It is telling teachers to make students aware of problems with what they call "Darwin's theory," but not of problems with Intelligent Design, because the prepositions they're using are different. They're made aware of gaps and problems in Darwin's theory. They don't say "and in other theories of evolution." But they say "and of" recurring to -- "students will be made aware of other theories of evolution."

There are no other theories of evolution. And to represent that to teachers in a curriculum and ask them to represent that to students in a classroom is

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fallacious. It's misleading. It's mendacious.

Q Now, do you -- let me ask again, Kevin. Do you know whether Intelligent Design is presented as a theory of evolution to students at Dover Area High School?

A Whether it has been presented as yet, I don't know. What I'm given to understand is that because teachers refused to follow this directive, that administrators came in and read the following four point or four paragraph statement to the students in the class with no discussion, no objection, and left.

Q Okay.

A Is that -- that's my understanding.

Q That is, and that's accurate.

If you look at that four paragraph statement, do you see that statement as holding out Intelligent Design as a theory of evolution?

A Yes.

Q Where?

A In the third paragraph it says, 'Intelligent Design is an explanation of the origin of life that differs from Darwin's theory.'

Darwin's view was not of the origin of life; it was of how species evolved. But in creationist's parlance, the words "origins" and "evolution" are constantly conflated. So this is code language, and it

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means the same thing.

Q Where do you get that from, Kevin? What accounts for that?

A Vast experience of 25 years of working with creationist literature in California and elsewhere. Work, for example, with my nonprofit. Works with -- before the nonprofit was formed when we were trying to keep creation science and anti-evolutionism out of the textbooks in California. That traces back to 1984, '86.

Q Do you have an understanding concerning whether Intelligent Design theory takes issue with the origins of life?

A Well --

MR. ROTHSCHILD: Objection.

BY MR. GILLEN:

Q Let me -- when you say, "origins of life," what do you mean by that, Kevin?

A What I mean -- when scientists speak about the origin of life; they don't use "origins," plural. They mean the first formation of the first living thing way back billions of years ago. We don't mean the origin of man or the origin of birds in the same, somehow, format. We mean the evolution of these things, but where life begins is the origin of life, and it has only one origin, as far as we know. And therefore, in that

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continuity of life, when we talk about the origin of birds, we mean the evolution of the first birds from things that were already preexisting. But life is coming out of things that are non-life, the study of the origins -- of the origin of life. The "origin of life," singular, is a very knotty problem that depends on very indirect sketchy evidence that can be formulated, as we've seen, in several different ways. And there are some very interesting and different hypothesis about lots of processes, the origin of life. So when scientists talk about it, it's just the single origin of life billions of years ago.

So here, in this paragraph, Intelligent Design is an explanation of the origin of life that differs from Darwin's view. Darwin didn't write his book about the origin of life. He wrote his book about how new species evolved from preexisting species. So these things all become conflated in anti-evolutionist language. And this is typical anti-evolutionist writing.

Then they go on to talk about Pandas and People and promote this as a reference for the explanation of life, by which they mean evolution or origins, whatever parliaments they feel like using. This is where the problems lie. Because as -- you asked the question, are

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they promoting Intelligent Design. Yes, that third paragraph is entirely about substituting Intelligent Design for a full explanation of Darwinism, or whatever Darwin's theory entails to them, which is really quite a different approach or understanding than scientists have.

Q Okay. And again, I want to get a grasp on this. It seems like, looking at that third paragraph or the four paragraph statement, when you see the term "origin of life," you're looking at that in terms of your sort of background knowledge of this creationist evolutionist debate. And you're saying that you understand that term, "origin of life," to be a reference to origin of the species?

A It encompasses not just the original origin of life, but also the emergence of major body plants and adaptations, major groups of organisms as well, including humans.

Q Okay. And if you look at -- I see that you have this objection that by just referencing the book Of Pandas, students are what, they're --

A By referencing Pandas, the school board is legitimizing this as a source of knowledge about biological evolution. It's legitimizing the idea that there are scientific alternatives to evolution, and it's

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legitimizing Intelligent Design as one of those alternatives.

Q Okay. Is there anything else in this statement that you think is problematic, from the standpoint of good science education?

A Well, we could talk about why they're confusing the scientific and common uses of the terms "theory" and "fact." And this makes it very problematic because it prejudices, in advance, examination of not just Darwin's theory or the whole theory of evolution, which is way more than Darwin's, but any scientific theory. It gives the impression that the school board believes that a theory, at some point, becomes a fact, perhaps when it's proven or otherwise demonstrated beyond all doubt. That is not at all what we mean in science when we use the terms "fact" and "theory."

And if students were given the impression that this is the case, they would be misled. And I believe this would thwart the school board's stated purpose of helping them to prepare well for standardized tests.

Q Well, what are you getting at there, Kevin? Is there no distinction between theory and fact?

A There is a distinction but, in fact, oddly enough, to a scientist, a fact is a much more trivial thing than a theory. A fact is simply a reported

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observation. It could be wrong. Facts are wrong all the time. Facts are not true. The school board's wording gives the impression that a theory becomes a fact. That is, that it becomes true after it has enough evidence to support it. But, actually, a fact is just a small component of a theory. It's an observation. Many observations are made. Many inferences are made. Many hypotheses are drawn from those inferences and tested repeatedly.

Many different disciplines can be pursued as they are relevant to exploring the consequences of this building mass of ideas. That eventually becomes a body we call a theory. When it seems like it's a pretty good idea that, for the moment, we're going to -- until something better comes along -- we're very pragmatic about this -- we're going to accept it as the best explanation we have.

So a theory, like a theory of -- I guess, I might call platetonics, which emerged from the old idea of continental drift. Platetonics is a theory because it doesn't just say that continents drift around through time, it gives mechanisms for those movements which we didn't have before. It shows how the plates of the earth are drawn back into the earth; how they come up against each other and build mountains ranges; how this

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makes earthquakes and volcanoes and rings of volcanoes, for example, as we see around the pacific continental rims.

The consequences of all this don't just apply to the surface, but they apply to our understanding of what goes on deep inside the earth where there are convection currents of heat, heated hot molten rock, hundreds of miles, thousands of miles, thick, coursing through the inside of the earth and erupting and causing these processes on the surface. There, in that whole thing I described, is the embodiment of the theory. Would any single fact come along and slay that theory? It's hard to think of one that would.

But the theory itself later on could be modified in any number of ways. Perhaps we'll learn that the relationship of the sun and the moon to earth's gravitational field is what -- that may provide another explanatory mechanism. It may take our focus off convective -- who knows what. We don't know where this is going to go, but the fact is that evolution is a theory that's just like that. We're as certain as we can be that this is a really good explanation of the diversity of life on earth. Does that mean we know everything about it? No. Does it mean we won't find new mechanisms? Of course, we will. Does it mean that

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existing mechanism we have now, we may find more or less important than the past? Of course not. All this, the more we study, the more we'll learn. And that's how science operates.

Q In your opinion, is there a possibility that that sum total of facts could, at some point, displace evolutionarily theory?

A Because scientists are legendary in being open-minded, the answer that I would be expected to give is, yes, obviously. But I think I should stress that science is open minded, but not empty-headed. And that means that we know a lot, and if we have this huge body of knowledge, there are two things that could displace it. One is, we'd have a bigger body of knowledge that says all this is wrong. Or, we could have some other observations and ideas that would take that body of knowledge, twist it 45 degrees and say, now we can explain it this way and it makes even more sense. And that's a paradyme shift. But to destroy a whole theory like the phlogiston theory -- that's p-h-l-o-g-i-s-t-o-n theory -- seems awfully unlikely in view of 150 years of research.

Q The accumulated successes of evolutionarily theory is such that you think it's unlikely that it will ever be displaced as the reigning theory in this area?

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A It may be modified, but to be completely thrown out, would be unlikely.

Q If you look at -- I'm sorry, Kevin.

A And I want to say in fairness, I don't think that ID is trying to do that.

Q What do you see it trying to do?

A I see it trying to add a certain special kind of explanation to the understanding of evolutionarily theory. That does not mean that all of its adherence accept or do not accept evolution as a fact or evolutionarily theory, as we know it today. But it does mean they're trying to add another explanation here that they think may displace it.

The language of these documents suggests that it is supposed to displace it. And as we discussed earlier, it's not clear why Intelligent Design has to be in conflict with evolution except that they are positing supernatural intervention, which is non-scientific. Science can't investigate it. So it comes back to that.

Q If we stay focused on this theory fact distinction, and I look at the bird net hypothesis, how does that fit in? Is that a theory; is that a fact?

A We would call it a hypothesis. That is a hypothesis of how this evolved, how this structure changed its function.

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Q So there's neither fact nor theory there?

A The facts that John used related to the structure of the first birds and the animals they came from; reasonable inferences about how their arms and legs moved, for example, how they could run, how they might move their arms; facts about what we knew then about the feathers of early birds and possible precursor structures.

So there were, of course, facts that he used to develop a hypothesis that then required further testing. And as we talked about before, one test of that was proposed by our colleagues in Arizona. And it was -- was persuasive with recourse to the evidence enough to suggest to John, and to the others, that maybe his proposal was not really explaining very much, and he agreed.

Q Well, and just to get -- you called that a hypothesis. Is it not a theory because it unifies a lesser range of observations; is that it?

A Yes.

Q Okay.

A It has a much simpler test to it.

Q So just as I try and labor through this, from your standpoint, Kevin, when it says, "Darwin's theory is a theory," that is accurate, I guess?

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A (Witness nods head.)

Q Is that?

A Yes.

Q "It continues to be tested as new evidence is discovered."

A Uh-huh.

Q That's true?

A Uh-huh.

Q The theory is not a fact is literally true, at least, but you've expressed these reservations because you think it conveys a misleading sense of what the term should mean?

A If someone said, is it a fact that life has evolved through time, I would say, yes, because it's a well-accepted understanding. Is it a fact that natural selection is important in the evolution of life? I would say, yes, because it's a well-tested observation in natural populations and in laboratory populations. We know that selection in these populations can have a very strong affect. So we do regard that as a fact, that selection is important in evolution.

Q Okay. So I guess you're saying some features of a theory are so well demonstrated that they are a fact?

A Yeah, they're factual. Life has a common

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ancestor, and all of life has evolved through time. These are propositions that the scientific community accepts by consensus. I would say, it's not necessary that every scientist in the world accepts all these things, or everyone who calls themselves a scientist accepts all those things, but it is the universal scientific consensus in countries, races, cultures, that operate in science. So the second sentence there is very problematic.

Q Then "gaps in the theory exist for which there is no evidence."

A "Gaps in the theory exist for which there is no evidence."

Well, without them saying what the gap is and what particular theory they're talking about, it's really hard to respond to that. It just seems like a -- it seems like a kind of a defamatory characterization, and that's all.

Q Do you -- I think you told me, but let me ask again. Have you ever spoken with the teachers at Dover about what they taught in the classes dealing with evolution prior to this statement?

A I haven't. Sorry, I have not.

Q Okay. But do you have an understanding as to whether there are gaps in evolutionarily theory?

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A If by that you mean, are there things we don't know yet and are there issues that are still debated. Of course, as there is for any theory. The characterization of these issues in questions as gaps seems to me pejorative and leading.

Q And when you say that, Kevin, why do you say that?

A It's leading students to believe that things are worse than they are. That there is disarray, perhaps even deception, that they are not being told of problems that exist that are really serious. When, in fact, the problems are not serious. Every evolutionist who writes for the public, from Stephen J. Gould on down, has stress that even though we may argue about whether punctuation or gradualism is more or less important, we do not deny that these organisms are all evolving through time, and they have common ancestors.

The insinuation that there is complete disarray, disagreement, chaos, and lack of understanding is simply false. And that is what statements like this survey having nothing in the statement to balance them.

Q And you're making that judgement, Kevin, based on your experience in - with critics of evolution?

A I'm basing it even strictly on what the words in the sentences say here. I think the words alone are

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enough to tell us, by their rhetoric, what they emphasize, what they deemphasize, what they say and what they don't say. That these paragraphs are largely there to criticize standard evolutionarily theory and to represent that there are other ideas that are scientific that are equally worthy, that somehow are not being presented in the curriculum, but that students can have resource to if they just read the Pandas book. And this is a gross misrepresentation of science and of good science education.

Q Because it's holding out Intelligent Design Theory as a scientific theory?

A And because it's criticizing standard evolutionarily theory in completely incorrect and inappropriate ways.

Q It seems to me, Kevin, what you're saying there is it seems overstated, the criticisms seems overstated?

A It's incorrect and biased. It's incorrect to imply that evolutionarily theory is completely in chaos and has big problems with it that students are not being told about in standard curriculum. It's biased in that it does not apply this kind of awareness to any other idea in the science curriculum or indeed, since it's the whole school board, to history, math, social studies. I mean, why don't they have a similar statement that says,

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well, the holocaust is one idea. But there's this other idea that the holocaust is a myth, and you can go to this book in your library and read about that.

Now, historians, as I understand it, although I'm happy to have you establish that I'm not a historian, would be almost universal in their condemnation of the holocaust myth notion. Yet we find many people in this country who are comfortable with it. If we represent that to children as being an equally good idea about an important history, important event in the last century's history, and that we represented this view has strong evidentiary support for it among the community of scholars that are historians, which should be what we teach in schools, I think that if you made that substitution, a lot of the parents in Dover would say, you know, you're right, this isn't fair.

Q And you get the implication from the second paragraph of the statement read to students?

A And the third one and the fourth one, which suggests that with respect to any theory, "students are encouraged to keep an open mind." And yet, the board does not address any other theory in any other curriculum or this one. It's only this one that they want students to keep an open mind about.

Q When you say that, Kevin, is it based on your

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understanding that this notion of keeping -- "students are encouraged to keep an open mind" is limited to evolutionarily theory?

A This is the only theory under discussion in the board's statement.

Q I think you said there's no -- you're not really familiar with any other -- the presentation of any other theories in Dover Area High School?

A I'm not familiar with any other statement the school board makes with respect to keeping open minds about, or in considering alternative theories that are not part of the standard curriculum.

Q Standard curriculum, meaning what?

A I presume that the teachers are working either from a state curriculum, a district curriculum, or from another stand curriculum that the board has accepted as something they should be dealing with. In either of these cases, I would define those as standard curriculum.

Q Let me ask you, on page 4 of your report, you've got the one, two, third paragraph down there, it says, if IDC were presented in science class as if it were science, and then you number -- number of consequences that you see following from that. The first is that students would completely misapprehend

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this structure and logic of science.

Now, we've gone through this statement, and that -- this is, I can tell you, the statement that's read at the beginning of the biology classes that deal with evolution. Do you believe that the reading of this statement would present this harm that I've just described from your report, "students will completely misapprehend the structure and logic of science"?

A Well, my paragraph says, Pat, that "if IDC were presented in science classes as if it were science." So my statements there are not applying specifically to simply walking into a classroom and reading this statement. So, for all I know, the guy could walk in, read the statement, walk out, the kids would go, huh, and then just go back to their video games or whatever they're doing.

Q Right. Well, I understand that, and that's why I'm asking you. I mean, the situation you described is, I think, you can -- let me say for the purpose of this question, assume that that's exactly what happened. The administrators walked in, they read the statement and walked out, and the teachers went on to give instruction, and that instruction was in evolutionary theory as it had been taught for 20 years at Dover.

My question is, do you think that that

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practice, that sort of practical consequence of that curriculum change, would present this harm, that "students would completely misapprehend the structure and logic of science"?

A One is tempted to wonder where it would end. Do you have the principal coming into the social studies class the next day and saying that, well, what you read here about European Imperialism and Colonialism in your history book is all well and good, but there's another theory that actually this is -- this was the manifest destiny of a superior European race that had a destiny and a legacy to concur everything in front of it, which is the way history was taught in the eyes of the people now writing it in decades previously.

Where will this end if you allow the whim of a special-interest-issue group to come in and simply countermand or contradict by virtue of the authority of a teacher reading this or a school board member or an administrator from school, coming in with the bravadoes of his position and saying, all of what you're hearing now, you know, there's a whole other side to this.

I find that that's just the poorest education practice I can think of. If you really had good evidence, it should be presented, assuming that it's scientifically valid. And students should understand

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why this is so, and should discuss it. But I think it's a matter of established fact among us that there was no discussion of this, nor did anyone feel a discussion was appropriate.

Q Well -- and I understand. I'm just trying to get a sense for the way in which the report relates to what's happening. Just to -- let me ask you, because I know you have a background in science education.

Do you think reading that statement will present this harm, that it would have such a dramatic -- this sounds to -- this is a serious thing, "students will completely misapprehend the structure and logic of science?"

And I -- you know, where they ended up is this statement. All I want to do is get your opinion. In your opinion, as a science educator, does the reading of that statement create that harm?

A I am not persuaded that the reading of that statement is the only or ultimate action that the school board would take as a result of its curriculum change. In the short time that it's been in force, we know that the actions of the school board have met tremendous resistance and controversy. And that, so far, this is all they have felt able to do, perhaps.

However, the intent and purpose of introduction

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to curriculum change is both religiously motivated and scientifically untenable. The effect that this has on instruction is not positive; it's negative. And so I don't feel that it's a relevant question to ask whether what they have done so far is harming anyone. I think that what they would like to do is far more than this and that it would be harmful. As it's done already, it's providing misdirection, falsehoods and misrepresentation of science to students. And you might say that no one's paying attention to it, and I won't agree or disagree.

The action as such, is poor science. It's poor pedagogy. It's poor educational practice. And those things are in of themselves harmful.

Q Well, look, I understand that, Kevin, I have total respect for you, your credentials, your background in science education, the information you've given me, frankly, here today. And I know why you might suspect that other actions might be taken down the road. I can understand that given the sources of information that you've had. But I just want you to answer that question that I've asked you. Which is, you know, if the -- this reading of the statement, in your opinion, as a science educator, does the reading of that statement create the harm that I've identified here, in your opinion, on page

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4, that students would completely misapprehend the structure and logic of science?

MR. ROTHSCHILD: He's answered that.

THE WITNESS: Remembering again, that my statement referred to if IDC were taught as science. But the reading of that statement, if people listened to it, and if a tree falls in a forest and no one hears it, we could debate that, but if people listen to it -- if it is meant to be listened to and heeded, then it would create harm.

I cannot tell you if students listen to it and, therefore, if it has created harm. That's not in my -- I don't have that experience directly to judge.

Q All right. Let me ask you this. If the statement were read, and if the statement was heard by the students, in your opinion as a science educator, would it -- would students completely -- did those students who heard it completely misapprehend the structure and logic of science?

A They would -- they would misunderstand, misapprehend what the structure of science is. Because if they heeded the statement, listened to it, and went and read Pandas and People, which is what the statement tells them to do, they would misapprehend what scientific understanding is, what the logic of science

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is, and what -- one thing, for example, is that the Pandas book is full of alleged questions, conundrums, and unsolved problems of evolution, as scientists understand it.

These, as I've detailed over many pages, are complete misrepresentations of the science, and they were when the book was written. So I would say for that on the first count, yes, if they did that, they would completely -- if they read Pandas and People, as they're told to do in class, it would completely misrepresent -- I'm sorry, they would completely misapprehend the structure and logic of science.

Q Would they, if they didn't read Of Pandas?

A I can't tell whether they would or would not. It sure wouldn't help.

Q How about just the same thing for 2 there, "understanding of evolutionarily biology would be deficient and misinformed"?

A Yes.

Q "And their training in science would be significantly inferior to that of other schools and to schools in other countries."

If we look at the students there, and we posit that they heard the reading of this statement but didn't read Of Pandas, do you think that harm would flow from

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the reading of that statement.

A I can't tell.

Q How about taxpayer dollars would be wasted? I mean, what's your -- what are you getting at there, Kevin?

A When students are introduced to false controversies, when they are told things that are misrepresentations of the understanding that's standard curricular are trying to get across, then tax payers' dollars are wasted. You're wasting time, you're wasting effort, you could be teaching them good science, good social studies.

Q On page 6, there's a paragraph that begins, that says, "If school children were taught according to IDC precepts, they would learn that a complex structure would be useless until it was fully formed."

When you say, "taught according to IDC precepts," Kevin, what -- what do you have in mind?

A Specifically Specified Complexity and Irreducible Complexity, which are the hallmarks of Intelligent Design Creationism, as we understand it.

Q Do you have any understanding concerning whether the students at Dover High School are taught those concepts?

A You tell me that, so far, only this statement

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has been read to them. I respond that, if down the line Intelligent Design were taught as if it were a scientific theory and as if it were an alternative evolution, then these things would happen.

Q The reading of the statement alone, would that -- would they learn that a complex structure would be useless until it is fully formed or was fully formed, the statement?

A The four paragraph statement by itself doesn't address those specifics.

Q You've got a reference here to -- as that sentence goes on, to the evidence for that a wing would be useless until it was fully formed, and that this is, therefore, evidence of a miraculous intervention of a Master intellect or Creator. If, as I tell you, just for the purposes of these questions, we're limiting to the statement, is that harm still present, in your judgment?

MR. ROTHSCHILD: Just to be clear, this posits a student who does not go and read Pandas?

BY MR. GILLEN:

Q Right.

A If a four paragraph statement states the term "Intelligent Design," and relates it to discussions about the origin and evolution of life. In those four

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paragraphs themselves, they do not directly address the specifics of miraculous interventions.

Q How about -- I mean, I just -- you ventured a number of opinions related to the teaching of some Intelligent Design concepts, Irreducible Complexity or Specified Complexity. As -- I don't want to belabor the process. The statement doesn't get into that, this is what they ended up with. Does -- in your judgment now, if you look at the situation as it's actually, you know, occurred, what's -- what's the end result of this contest between the Board and different facets of the community, does it present the harms that you were concerned about when you drafted your expert report?

MR. ROTHSCHILD: Objection, asked and answered.

THE WITNESS: I think that we -- if we can admit, as agreed, that so far this statement has been read by administrators, not teachers, and these administrators then left the classroom, and teachers went on with whatever they were doing, then we also should be able to admit the fact that, as I understand it, there has been a lot of heated controversy and argument in the Dover community at school board meetings and super market aisles, who knows, on telephone calls among people. And who knows the extent of the confusion, misunderstanding and damage that has resulted

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from the Board's action of taking an unproblematic, straightforward concept, universally accepted by scientific societies and the consensus of scientists, and pretending that it's riddled with problems, and that there's an alternative idea that should be taught alongside it, and should be done.

I believe if you wish to say, did this action alone create harm, it is not just this action, but the passage of these actions by the Board and the strife and turmoil that has existed and resulted in that community, as a result of this action, that is going to leave a scar on that community for a long time to come no matter how this is decided. And I have to ask myself, is it all worth it to try to take this little special pleading that's not even wrong. It's not even wrong because it's not even science. And to say here, we have to put this on equal footing. What kind of good can that action have inside and outside of the classroom?

I do not feel it is fair to judge the consequences of the Board's action simply by whether reading the statement in the classroom has caused harm. What has happened in the Dover community, if news reports and everything that you and I hear is any indication, it's a turmoil and confusion, and a misrepresentation that could have been completely

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avoided.

Q Okay. Those are sort of extra science education considerations?

A I don't think so, because I don't think that students only learn in the classroom. I think that they learn a lot from discussions that they have and that they hear outside the classroom. And if this buzz in the community is anywhere near as great as news report would have us understand, you wonder who is guiding that discussion outside the class, which is probably far more than the discussion in class. What other kinds if -- excuse me.

If the Dover School Board can be so uneducated and misled about basic science as to take actions like this, what about the other people in the community who don't have their experience and wisdom? I presume that they're on the board because they're regarded as educational leaders in their community. If that's the case, what about the people that don't have their breadth of knowledge and experience? What kind of discourse is being fostered by this confusion among all those people who have no authorities to turn to?

Q Let me understand you. Is it your view that any discussion of Intelligent Design is harmful?

A No. Rather, that the actions of the Board have

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created a false controversy about science and science education that have repercussions beyond the time it takes or the form that it represents to read four paragraphs by an administrator in a science classroom.

And I think it would be negligent not to acknowledge that or try to limit the problems or the damage to what happens to a few students that hear somebody read this in a classroom.

Q If we focus on the students hearing the statement read, as we sit here today, are there any other harms that you can see inuring to those students in the classroom that follow from the reading of these statements?

A I believe you would have to ask those students and their parents and the other members of their community.

Q Kevin, on page 14 of your report, you say that "IDC proponents reject the standard methods of science."

A Yes.

Q Just give me a sense for what you're understanding is in that regard, what methods do they reject?

A One method, that it restricts examination to natural phenomena, not supernatural ones.

Q Any others?

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A One method of science is, when possible, either to set up experiments and to carry them out. I have not seen any experiments carried out with reference to IDC. Another method would be to use phylogenetic comparative methods to examine whether the evolution of the structure could occur or whether, for example, it was too complex or had too much Specified Complexity to evolve. I've seen no work done or submitted according to those methods. And I think one method that applies to the scientific community that is important to stress, is its submission to peer review, which has never been done, as far as I know.

Q Any other methods?

A I can't think of specific cases right now. They may come up in further discussion.

Q Let me just ask you. Now, if we contrast that with Darwinian theory, as it's called in the statement. Evolutionarily theory, I think, as it's known, apparently, in the professional community today, is that falsifiable?

MR. ROTHSCHILD: Objection to the form.

THE WITNESS: However we characterize our evolutionarily theory or Darwinian theory, to say that a theory is falsifiable would suggest that everything about it is wrong. Is it testable, are aspects of it

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testable and even falsifiable? Yes, of course, sure.

BY MR. GILLEN:

Q Could there -- let me -- I'm trying to get a sense for how -- plainly, you see this differentiation here between Intelligent Design Theory and evolutionarily theory. And we've -- at several points today, we've talked about it being testable or parts of it being testable. And you have the conviction that there's no testable elements to Intelligent Design Theory; is that correct?

A What I said is, that the supernatural part of it is not testable scientifically, because science's purview is only in the natural world. These things may or may not be true, but they are not part of science.

Q Are there other parts that are testable?

A There are parts that may or may not be testable, but they have not been proposed in the scientific community in testable terms. And that's why we talked about the idea that Behe and Dembski, for example, have said certain things or they have written certain things, but they have not subjected this to peer review. And even when they've been criticized, they have not responded in many respects, a problem of which their critics complain. And so, what these guys seem to want is -- is "double indemnity" the right word, maybe

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not. They want it both ways. They want to be able to come in and say that they've got the greatest thing since sliced bread, but they don't want to say that in the scientific form, and they don't want to respond to scientific criticisms in a scientific form.

If this is the case, why is this science? The process, the de facto nature of science, this isn't it. This isn't it. They're not doing it.

Q Now, just so I get you, you're contrasting that with evolutionarily theory, where you said that parts of it are testable?

A I can think of probably a dozen journals off the top of my head, in which every aspect of evolutionarily theory is routinely reported, tested, modified, enlarged, expanded, and in some cases, rejected.

Q Okay. But those, as you see it, apparently, they have no implications for the over arching thrust or tenants of evolutionarily theory; is that fair?

A No. They have every bit as much.

Q You're right. My question was imprecise. But in terms of falsifying the theory, they don't pose significant challenges to the overall standing of the theory?

A Sure they do. Sure. We can take any number of

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components of evolutionarily theory, and they're being challenged all the time. Punctuated equilibria challenged that notion that the prevailing pattern of evolution is slow and gradual. That's a huge challenge. It was regarded as such. In fact, it was regarded as a greater challenge than its proponents suggested. They thought they were doing everybody a favor and saying, hey, look guys, here's the way things really change, and you know what, it agrees more with your modern models of speciation than with the old outmoded ideas that we used to think about, so.

Q Do you have any sense that evolutionarily theory, as such, can be falsified through the accumulation of these tests?

A Do you mean that the entire structure and corpus of evolutionarily theory can be falsified?

Q Yeah.

A Well, it's funny to say so, but in theory, yes. That is to say, of course, everything we think now can be modified and changed so as to be different from the way we've seen it. Is Intelligent Design likely to do that? Certainly, it shows no sign of it so far.

MR. GILLEN: I have no further questions.

MR. ROTHSCHILD: Mini script and ASCII and exhibits. You'll get the original exhibits.

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MR. GILLEN: She'll put a copy on the original, and I'll take the same.

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I, KEVIN PADIAN, do hereby declare under penalty of perjury that I have read the foregoing transcript of my deposition; that I have made such corrections as noted herein, in ink, initialed by me, or attached hereto; that my testimony as contained herein, as corrected, is true and correct.

EXECUTED this ____ day of _____, 2005, at _____, _____.
(City) (State)

_____
KEVIN PADIAN

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I, the undersigned, a Certified Shorthand Reporter of the State of California, do hereby certify:

That the foregoing proceedings were taken before me at the time and place herein set forth; that any witnesses in the foregoing proceedings, prior to testifying, were placed under oath; that a verbatim record of the proceedings was made by me using machine shorthand which was thereafter transcribed under my direction; further, that the foregoing is an accurate transcription thereof.

I further certify that I am neither financially interested in the action nor a relative or employee of any attorney of any of the parties.

IN WITNESS WHEREOF, I have this date subscribed my name.

Dated: _____

_____
ANA VIDA REID
CSR No. 11926

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